BROOKHAVEN NATIONAL LABORATORY

INSTITUTIONAL PLAN
FY 1999 --- FY 2003

DECEMBER 1998

BROOKHAVEN SCIENCE ASSOCIATES, LLC.
UPTON, NEW YORK 11973

BROOKHAVEN NATIONAL LABORATORY

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Operated by
BROOKHAVEN SCIENCE ASSOCIATES
FOR U.S. DEPARTMENT OF ENERGY
CONTRACT NUMBER DE-AC02-98CH10886

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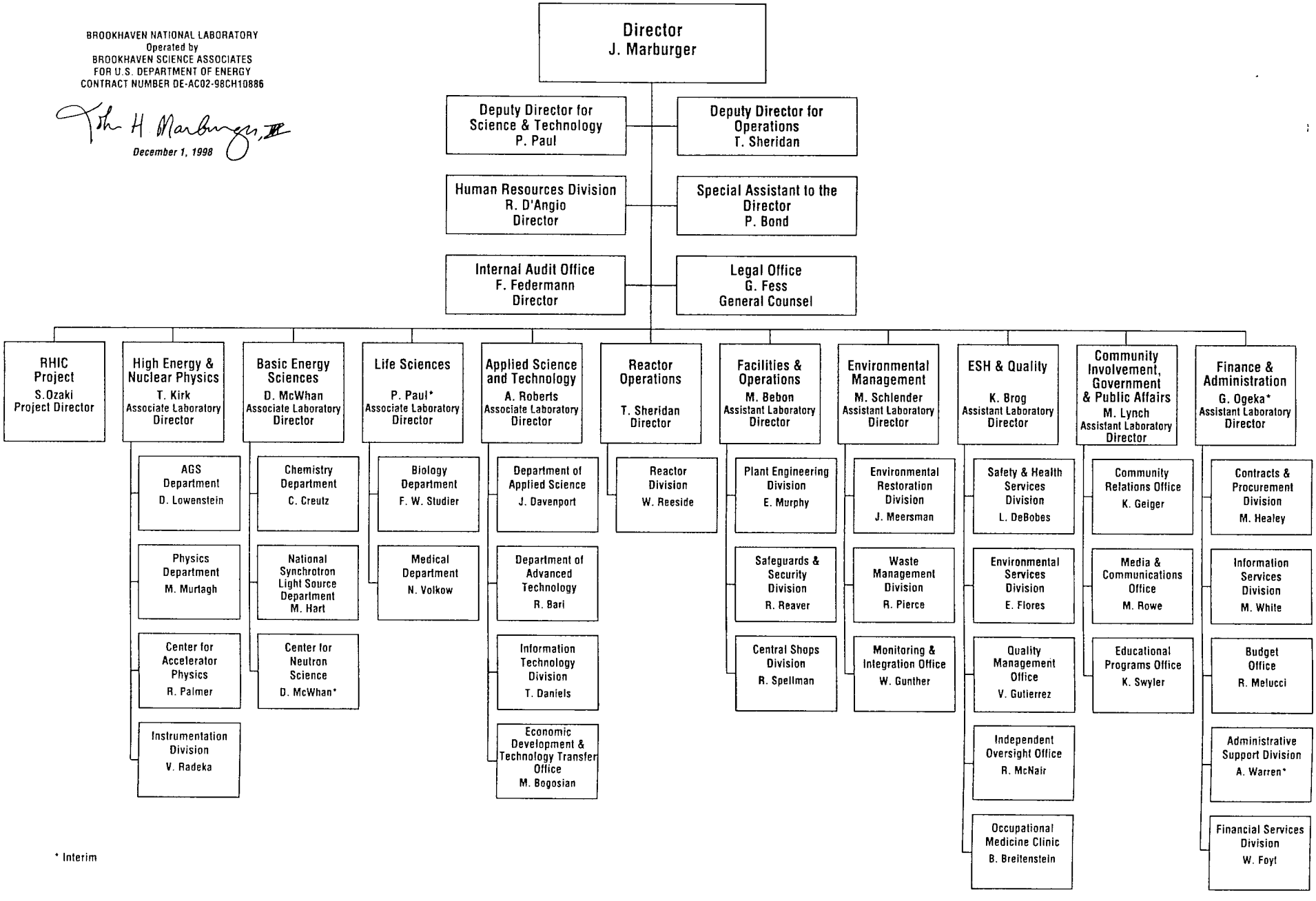
December 1, 1998



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BNL	Brookhaven National Laboratory
AGS	Alternating Gradient Synchrotron
ARM	Atmospheric Radiation Measurements
ATF	Accelerator Test Facility
BES	DOE Office of Basic Energy Science
BGRR	Brookhaven Graphite Research Reactor
BHG	Department of Energy Brookhaven Group
BMRR	Brookhaven Medical Research Reactor
BNCT	Boron Neutron Capture Therapy
BSA	Brookhaven Science Associates
CCATS	Commitments and Corrective Action Tracking System
CCD	Computing and Communication Division
CDR	Conceptual Design Report
DOD	United States Department of Defense
DOE	United States Department of Energy
DOT	United States Department of Transportation
DUV-FEL	Deep Ultraviolet Free Electron Laser
EM	DOE Office of Environmental Management
EPA	United States Environmental Protection Agency
ES&H	Environment, Safety, and Health
ESHD	Environment, Safety and Health Services Division
FACE	Free Air Carbon Experiment
FEL	Free Electron Laser
FSD	Financial Services Division
FTIR	Fourier Transform Infra-Red Spectroscopy
GIS	Geographic Information System
GPE	DOE General Purpose Equipment
GPP	DOE General Plant Projects
HENP	DOE Offices of High Energy and Nuclear Physics
HFBR	High Flux Beam Reactor
IAG	Inter-Agency Agreement
IM	Information Management
ISD	Information Services Division
ISMS	Integrated Safety Management System
LANL	Los Alamos National Laboratory
LHC	Large Hadron Collider
LLNL	Lawrence Livermore National Laboratory
MEL/FS	DOE Multi-Program Energy Research Facility Services
MRI	Magnetic resonance Imaging
MRS	Magnetic Resonance Spectroscopy
MSIP	Management System Improvement Program
NABIR	Natural and Accelerated Bioremediation Initiative Research
NIH	National Institute of Health
NNDC	National Nuclear Data Center
NSF	National Science Foundation
NSLS	National Synchrotron Light Source
OBER	DOE Office of Biological and Environmental Research
OER	Department of Energy Office of Energy Research
ORNL	Oak Ridge National Laboratory
P2	Pollution Prevention
PDB	Protein Data Bank
PET	Positron Emission Tomography
PRA	Probabilistic Risk Assessment
R&D	Research and Development
RHIC	Relativistic Heavy Ion Collider
SLAC	Stamford Linear Accelerator
SNS	Spallation Neutron source
STEM	Scanning Transmission Electron Microscope
STM	Scanning Transmission Microscope
SUNYSB	State University of New York at Stony Brook
UCLA	University of California at Los Angles
XAS	X-ray Absorption Spectroscopy

Executive Summary

Brookhaven National Laboratory (BNL) will continue to explore the frontiers of science and technology as we approach the 21st century, with a new management team demonstrating a strong commitment to community concerns and environmental protection.

Based on the U.S. Department of Energy's mission and Strategic Plan, Brookhaven's institutional plan focuses on programs that have established us as a leader in science and technology. To continue our tradition of scientific excellence while meeting the challenges facing us, Brookhaven's new managers, Brookhaven Science Associates (BSA), will implement more effective management processes and establish stricter standards of accountability.

In the next five years, BNL will implement new initiatives that advance DOE's mission and continue to concentrate on research in our core competencies: physics of energy and matter, materials and chemical sciences, biological sciences, environmental sciences and technology, and radiation-based medicine.

This plan addresses Critical Outcomes for the Laboratory – the highest priority results that Brookhaven will accomplish by 2004. These include increased productivity in research, combining interdisciplinary collaborations for more effective research, and the continued commitment to provide premier user facilities to the international scientific community.

In addition, BNL will press ahead in developing a talented, diverse work force with goal-oriented managers and we will demonstrate, through benchmarking, that we are among the best in class for research & development institutions.

Brookhaven pledges to be an exemplary environmental steward by cleaning up legacy wastes and implementing environmental cleanup in a cost-effective, timely manner. We will significantly reduce waste we generate. Additionally, we will implement a new communications plan that is responsive to both internal and external stakeholders, recognizing that public support is vital to the accomplishment of our mission.

The new millennium will bring many new challenges in science and technology for Brookhaven. We expect to continue to make contributions to diverse areas of science that will benefit society and improve national competitiveness. Over the next five years, BNL will be commissioning our world-class Relativistic Heavy Ion Collider, investigating new frontiers of matter, and exploring the chemistry of the human brain. We are confident that these and other important efforts will lead to advances in basic and applied research, thus furthering DOE's objectives in the key mission areas of energy, environment and national security.

1. Director's Statement

This is the first Institutional Plan prepared for Brookhaven National Laboratory (BNL) under the management of Brookhaven Science Associates (BSA). The plan sets forth our strategy for embarking on the second half-century of the Laboratory's history of outstanding service to basic and applied science. Our primary aim is to work in partnership with the Department of Energy (DOE) to produce excellent science and technology in a safe, environmentally benign manner with the cooperation, support and appropriate involvement of our many communities.

Planning Process: Our approach to planning intends to reinforce the innovations BSA brings to the Laboratory. These include the redefinition of roles, responsibilities and accountabilities of all managers, organizational realignments to support these roles, and new operating mechanisms. In the new organization, Associate and Assistant Laboratory Directors, who report to me, take full responsibility for all operations that produce the work in the programs reporting to them. They coordinate their work through the Integration Council, which also includes the Laboratory Director and the two Deputy Directors. I have therefore identified the Integration Council as the Strategic Planning Council.

Continuity with Past Performance: BSA assumed responsibility for BNL operations only a few months before the Institutional Plan was to be submitted to DOE. The Plan therefore reflects program directions that were largely laid out under the previous management. Many of BNL's departments have developed solid plans for the future. This fact, and the work done by BSA, BNL, and DOE during the procurement and transition periods before March 1, allowed us to create a Plan that we believe accurately presents our intentions. Some of the most important programs have well defined trajectories into the future. Examples are the construction and operation of the Relativistic Heavy Ion Collider and its detectors, our role in the construction of the Spallation Neutron Source, the future deployment of the Alternating Gradient Synchrotron, the continued operation and enhancement of the National Synchrotron Light Source, the development of the next generation free-electron laser light source, and the feasibility of a Muon Collider for high energy physics. Other areas have developed strengths and capabilities that suggest natural extensions. These include studies of cancer therapy based on the on-going work at the Brookhaven Medical Research Reactor, advancement of medical imaging techniques, and new frontiers in structural biology, environmental technology, and the materials sciences. Still other areas and facilities have futures that depend upon funding and decisions that are difficult to predict. The High Flux Beam Reactor is such a facility. Another is the Protein Data Bank, an asset important to our future plans that can only be retained by our success in open competition with other institutions. Based on existing strengths and on new needs and opportunities, the new management has identified four strategic initiatives across the core sectors of the Laboratory.

Alignment with DOE's Mission and Themes: BSA is committed to exploiting the exceptional strength of BNL's capabilities to mount programs of the highest quality that address DOE's Strategic Missions. Of the Four Businesses identified in the Secretary of Energy's Strategic Plan, Brookhaven National Laboratory contributes most

strongly to Science and Technology. Our contribution to this business endeavor has always been, and will continue to be, to advance the frontiers of knowledge of the structure of matter on all scales, and to operate extraordinary facilities for the production of cutting-edge science. These are two of the four themes articulated by the Director of the Office of Energy Research (OER).

While maintaining traditional strengths in science and technology, BNL intends to participate more effectively in the other three business areas defined by DOE: Energy Resources, National security, and Environmental Quality. We believe BNL has much to offer in these areas through the departments assembled under the Associate Laboratory Director for Applied Science and Technology, a new Directorate in the BSA organization.

BNL at the Fulcrum of Contemporary Science: The chief characteristic of basic science today is the merging of microscopic and macroscopic knowledge. During the closing decades of the twentieth century, rapidly advancing information technology, including large-scale computing and visualization, combined with advanced imaging facilities based upon accelerator and reactor technologies, made it possible to link the large scale properties of complex structures to the microscopic behavior of their constituent particles. This linkage extends across all natural science, spanning the spectrum of complexity from large nuclei (or the quark-gluon plasma for whose production RHIC is designed) to living organisms. Brookhaven National Laboratory is uniquely positioned to contribute to the most productive regions of this vast frontier between large and small. Its accelerator and reactor technologies have led to innovative designs for all the world's most highly valued instruments for microscopic study. Our plans include continued advances in facilities such as the muon-collider and the next generation free-electron laser light sources. They encompass further work on the properties of the simplest components of matter as well as explorations of the human brain, the most complex object known to science. And because this grand linkage provides the most powerful tools for solving problems of human scale, our plans include the transfer of these tools, and sometimes the solutions of the problems, to public commerce.

Our Obligation to the Community: None of our work can be carried forward without the support and understanding of our customers and our various communities. The resolution of problems in management and community relations identified during the past year is our greatest challenge in the months ahead. This Institutional Plan provides the first opportunity for our new team to show how techniques first proposed at BNL in the ongoing Management Systems Improvement Program (MSIP) will pervade every area of Laboratory operation under BSA management. The MSIP responds directly to the analysis and recommendations of the April 1997 DOE Environment Safety and Health (ES&H) Evaluation Report. BSA plans to broaden the scope of the MSIP to include more Laboratory operations. The Institutional Plan also allows us to articulate a coherent plan of community action that is focused on cleaning up the site; opening it to public scrutiny; expanding the publics understanding of the Laboratory; working together with the community to resolve specific issues, and contributing meaningfully to economic development and the quality of life on Long Island.

Few institutions established by the United States government have been as beneficial for society as Brookhaven National Laboratory. We have a strong obligation to harness the assets of the Laboratory for continued productivity in a balanced, focused program that builds on our unique strengths and moves forward under sound management in partnership with DOE, while protecting our employees and our environment, and promoting the well being and involvement of our community.

2. Laboratory Mission and Core Competencies

2.1 Mission

Brookhaven National Laboratory is a multi-program national laboratory operated by Brookhaven Science Associates for the U.S. Department of Energy. The Laboratory's broad mission is to produce excellent science and advanced technology in a safe, environmentally benign manner with the cooperation, support, and appropriate involvement of our many communities. Specifically, the elements of the BNL mission, which supports the DOE strategic missions, are the following:

- To conceive, design, construct and operate complex, leading-edge, user-oriented facilities in a safe and environmentally benign manner that is responsive to the DOE and the needs of the international community of users.
- To carry out basic and applied research in long-term programs at the frontier of science in support of DOE missions.
- To develop advanced technologies that address national needs and to transfer them to other organizations and to the commercial sector.
- To disseminate technical knowledge to educate new generations of scientists and engineers, to maintain technical capabilities in the nation's workforce, and to encourage scientific awareness in the general public.

2.2 Core Competencies

Brookhaven National Laboratory is successfully accomplishing its mission as a result of the caliber and skills of the scientific and technical staff, the integration of research disciplines, and the technologies and facilities available to staff and users for research and development in a broad range of scientific fields.

The Laboratory's core competencies which provide the basis for our contributions to the DOE's missions center on providing extraordinary tools for science and pursuit of basic science and technology.

In facilities our core competencies are the following:

- ***Accelerator Design and Engineering:*** Operations and improvements to the world's highest intensity proton synchrotron (AGS), design and construction of the Relativistic Heavy Ion Collider (RHIC), operation and improvement of synchrotron light source, free electron lasers, RHIC and Large Hadron Collider (LHC), polarized beams, Spallation Neutron Source studies, superconducting magnets;

- ***Detector Design and Engineering:*** Collider detectors, PHENIX and STAR, ATLAS, advanced neutron and x-ray detectors;

In basic science and technology the following are our core competencies:

- ***Physics of Energy and Matter:*** High energy, nuclear physics, and solid state physics;

- ***Materials and Chemical Sciences:*** Catalysis, chemical dynamics, combustion, magnetism, superconductivity and surfaces, corrosion, electrochemistry, photo- and radiation-chemistry, conducting polymers;

- ***Biological Sciences:*** Structural biology, molecular genetics, genomics, biotechnology;

- ***Environmental Sciences and Technology:*** Atmospheric chemistry and physics, aerosols, terrestrial carbon cycle, bio-remediation, sediment decontamination, waste management;

- ***Imaging:*** Brain studies, Positron Emission Tomography (PET),Magnetic Resonance Imaging (MRI), Boron Neutron Capture Therapy (BNCT), radiation therapy;

- ***Systems Analysis and Modeling:*** Probabilistic Risk Assessment (PRA), seismic structural analysis, global climate change.

- ***Nuclear Science and Technology:*** Fuels and materials, thermal hydraulics, human factors.

2.3 Supporting Capabilities

The capabilities that exist in the Laboratory allow us to build, operate and use an array of facilities:

- ***High Energy and Nuclear Physics:*** Relativistic Heavy Ion Collider (RHIC), Alternating Gradient Synchrotron (AGS), Accelerator Test facility (ATF), Superconducting Magnet Development and Construction facility;

- ***Macroscopic Structures and Imaging:*** National Synchrotron Light Source (NSLS), Scanning Transmission Electron Microscope (STEM), Magnetic Resonance Imager (MRI), Positron Emission Tomography (PET), High Flux Beam Reactor (HFBR);

- ***Data and Computation:*** RHIC Computing Facility, RIKEN teraflop computer, Protein Data Bank (PDB), National Nuclear Data Center (NNDC), Visualization Center;

- ***Treatment:*** Brookhaven Medical Research Reactor (BMRR), Radiation Therapy Facility (RTF).

- ***Production:*** Brookhaven Linac Isotope Producer (BLIP), Tandem Van deGraaf Facility.

3. Laboratory Strategic View

3.1 Laboratory Vision

Brookhaven National Laboratory envisions accelerating progress in the discovery of fundamental knowledge of the structure and interactions of matter , and in linking of this knowledge with the practical technologies needed to address society's most challenging problems.

To realize this vision, the Laboratory must maintain a stimulating research environment that will attract creative scientists and engineers. In this way the Laboratory will continue to devise and develop innovative and powerful facilities. These will permit researchers from all over the world to do research at the frontiers of science, and will foster the application of those facilities to problems of national significance consistent with the Department of Energy's missions and key objectives. These facilities must include not only the machines for which this Laboratory has become famous, but also the means of processing, visualizing, and interpreting the increasingly voluminous data produced. Complementing these facilities will be a system of recruiting and supporting users that inform new scientific audiences about the rapidly evolving potential of the facilities for their fields, and brings to public attention the importance of fundamental science to contemporary social issues.

The future of Brookhaven National Laboratory is one of growing complexity. Although the machines and processes that probe microscopic scales spring from basic physics, the applications of these facilities span the entire spectrum of materials, chemical, and biological sciences. Within DOE's missions, the diversity of science and technology that will be pursued in our Laboratory will increase substantially during the next decade. This diversity challenges management, and we will respond with increasingly effective and sophisticated management techniques. In the immediate future, management improvements will be driven even more strongly by heightened societal concern for potentially negative side-effects of the creation and application of new knowledge. The Laboratory will manage itself in such a way that the effects of its operations are more apparent to its regulators and its communities, and the results of its work add measurable value to the region.

The future of Brookhaven National Laboratory also is one of increasing engagement with people from both within and outside its boundaries. The Laboratory will find ways to share a sense of responsibility and accomplishment with its employees, and to recognize and reward them for their contributions to every aspect of the Laboratory's mission. The Laboratory will extend this shared sense of accomplishment our communities by openly and sincerely asking for advice, by communicating with credibly and comprehensibly, by creating effective mechanisms for resolving issues, and by using our technological resources to bring economic benefit.

The success of Brookhaven National Laboratory depends singularly upon the quality of its people. Only by maintaining the highest standards of excellence in each of the talents, skills and crafts needed to produce the whole will the Laboratory secure and maintain the position of world leadership to which it aspires. The Laboratory will accomplish this through rigorous and candid self-assessment, by accepting responsibility

for its actions and commitments, by energetic recruitment and retention of new talent from diverse populations, and by continual attention to training and self-renewal.

3.2 Fundamental Strategy and Critical Outcomes

The Department of Energy, in the 1997 DOE Strategic Plan (September 1997), identified four business lines or missions, that ". . . most effectively utilize and integrate our (DOE) unique scientific and technological assets, engineering expertise and facilities, to achieve our (DOE) mission and to benefit the Nation." Those four business lines are Science and Technology, Energy Resources, National Security, and Environmental Quality.

Brookhaven National Laboratory plays a principal role in the Science and Technology mission, maintaining an extensive research and development (R&D) portfolio in both basic and applied research, and in technology development. BNL also contributes strongly to the other DOE missions. We engage in extensive collaborations with other laboratories, federal agencies, universities and industries to meet the challenges facing the local, regional, and national communities.

The DOE Office of Energy Research developed four themes to guide its strategy for Science and Technology:

- Fueling the Future: Science for an Abundant and Clean Energy
- Protecting the Living Planet: Energy Impacts on People and the Biosphere
- Exploring Matter and Energy: Building Blocks of Atoms and Life
- Extraordinary Tools for Extraordinary Science: National Assets for Multidisciplinary Research.

Since these themes crosscut all DOE business lines, we have adopted them as guides for our strategy. They have been used in this plan to help us develop our programmatic focus and direction into the next millenium (see Figure 1).

BNL, in partnership with DOE Brookhaven Group (BHG), defined a set of Critical Outcomes and Objectives for the Laboratory to further define the strategy. These are the highest priority strategic results that BNL will deliver to DOE in the next three to five years. These seven Critical Outcomes support the DOE mission, will demonstrate significant improvements in managing the Laboratory and firmly set BNL on the path to acceptance by our communities. The Critical Outcomes are the following.

(1) Basic Science & Technology: We will continue to deliver innovative science and technology aligned with DOE strategic goals in a safe, environmentally sound, and efficient manner. We will educate and train our next generation of scientists as tomorrow's premier researchers.

Objectives:

- Continue to improve research productivity of the Laboratory.
- Develop new directions in basic science and technology programs.
- Establish the Laboratory as a major contributor to DOE's computational science program through our data intensive computing accomplishments.

- Increase the number of research associates and students in Laboratory programs.

(2) Strategic Growth in DOE National Priorities: We will achieve strategic growth of the science and technology programs, targeting DOE's energy, environment, health, and national security missions and related work for other federal agencies, and effectively deploy the resulting technologies and processes in both public and private sectors.

Objectives:

- Bridge the disciplines to expand collaborative research programs between BNL departments, other DOE Laboratories and with external groups to bring the integrated solution to our customers; and effectively transfer the results to our different stakeholder groups.
- Integrate our materials, chemical, nuclear and biological science capabilities to provide cost effective, safe and environmentally sound solutions to regional, national and international energy issues.
- Develop comprehensive approaches to enhance programs in land-use management, pollution prevention, waste treatment and environmental remediation and solutions for global climate change and carbon management.
- Identify and exploit our user facilities for imaging and radiation therapy and develop and apply novel approaches to human health issues.
- Develop, enhance and expand BNL's national security capabilities to prevent the spread of nuclear, biological, and chemical weapons and protect critical infrastructure.
- Identify, protect and deploy BNL technologies and technical capabilities that have commercial potential.

(3) Premier User Facilities: BNL will continue to provide world-class user facilities.

Objectives:

- Deliver and commission RHIC on time, within budget, and fulfilling its design parameters.
- Operate a world-class fixed-target program at the AGS.
- Operate and enhance the NSLS to optimize scientific output.
- Successfully complete activities in support of the future decision for the HFBR.
- Construct and demonstrate a deep-ultraviolet Free Electron Laser for chemical research.
- Operate and enhance other user facilities to optimize scientific output.

***(4) Communications and Trust*:** BNL will be recognized as a community asset, a good neighbor, and a valued employer.

Objectives:

- Enhance the responsiveness and effectiveness of Laboratory communications with internal and external stakeholders.
- Create opportunities for stakeholder involvement and participation in Laboratory decision making processes.
- Achieve a better understanding between internal and external stakeholders.
- Develop appropriate communications management and infrastructure.

***(5) Leadership*:** BNL will be recognized by DOE users and staff as a national laboratory with high quality leaders and the most effective and efficient management.

Objectives:

- Create a pool of talented, diverse, empowered, and goal-oriented leaders/managers.
- Provide effective and efficient business management, including the required systems for financial, information, and human resources.
- Provide high quality work environment which permits BNL to attract and retain an excellent workforce.
- Develop and implement a Laboratory-wide self assessment program.

(6) Operational Excellence: BNL will conduct work and manage laboratory facilities with distinction, fully integrated with the scientific and technology mission, while being fully protective of workers, public, and the environment.

Objectives:

- Conduct all work to achieve excellence in worker safety and health, and environmental protection.
- Provide facilities of distinction and provide facilities services with distinction.
- Develop and implement the BNL Facility Use Model.
- Implement improvements to management systems.

(7) Environment & Clean-up: BNL will be an exemplary environmental steward through safe and aggressive environmental clean-up, efficient waste management, and effective communications of the environmental health of the Laboratory.

Objectives:

- Minimize generation of future wastes.
- Eliminate legacy wastes.
- Understand and communicate past, current, and future environmental impacts.
- Implement environmental clean-up remedies in a cost-effective and efficient manner.
- Ensure stabilization of legacy facilities.

Our commitment to DOE is to achieve these critical outcomes, to deliver innovative science and technology aligned with DOE's missions, to grow our programs through interdisciplinary collaborations focused on the nation's needs, and to provide world-class user facilities. We will do so as an accepted member of the community, in a safe and environmentally sound manner.

3.3 Program Strategic View

3.3.1 High Energy and Nuclear Physics (KA/KB)

BNL works at the forefront of high energy and nuclear physics (HENP), with programs focused on the theme of exploring energy and matter; probing for answers to the following key questions:

- What are the fundamental components of matter and their interactions?
- What is the physics of extreme states of matter?

Our objectives include bringing the Relativistic Heavy Ion Collider (RHIC) on line within budget and on schedule, collaborating in the Large Hadron Collider (LHC) project, investigating the next generation of collider facilities, continuing the overall

performance and scientific output of the Alternating Gradient Synchrotron (AGS), and maintaining a strong, in-house staff of researchers to support and enhance the scientific productivity of our user facilities. Meeting these objectives will achieve two of our Critical Outcomes: Basic Science and Technology, and Premier User Facilities, and we will significantly advance DOE's overall science and technology mission.

The future programmatic direction of the DOE's High Energy and Nuclear Physics basic research program was mapped by agency-sponsored studies (Nuclear Science: A Long Range Plan, February 1996, and Planning for the Future of High Energy Physics, February 1998). These plans were prepared by the Nuclear Science Advisory Committee (NSAC) and the High Energy Physics Advisory Panel (HEPAP), respectively. Brookhaven's objectives for the HENP programs are consistent with the recommendations of both reports and follow the directions recommended as the highest scientific priority.

RHIC: Brookhaven is well positioned to assume a leadership role in both nuclear and high energy physics. The new RHIC facility is at the top of DOE's new facility investments in the future of nuclear physics, it will have no competition in the world until the LHC begins operating a second, higher energy heavy ion collider after 2005. RHIC begins heavy ion operations in 1999, and will be the first facility to produce conditions that have not occurred in the universe since a few microseconds after the "Big Bang". Over 1,000 experimenters from all over the world will work at RHIC, using four complementary experimental detectors. On-going collaboration with the RIKEN Institute of Japan will add to RHIC a unique capability to study the spin-related physics resulting from the collisions of the world's highest-energy polarized protons. This will allow us to determine the distribution of the glue in nucleons and nuclei that binds quarks together. The RHIC science program will be the most exciting and productive basic research program in nuclear physics for the next decade and beyond.

AGS: BNL's distinguished record of productive research and important discoveries, in high-energy physics, will continue well into the future. The current studies of rare kaon decays, hadron spectroscopy, precision muon g-2 measurements, and other special topics will segue into a smaller program focused on experiments of the most compelling scientific interest to the HEP research community. The experiments chosen will exploit the fact that the AGS stands alone in the world for its beam intensity and cost-effectiveness. Some planned experiments will advance our knowledge of the mysterious phenomenon of CP-violation first discovered in neutral kaon decays at BNL in 1964. Other experiments will exploit certain rare muon processes that enable researchers to probe new physics at mass scales and energies beyond those that can be explored even with the Large Hadron Collider. These prospects for particle physics necessitate continued use of the AGS for about 10 years to fully exploit the scientific opportunities

Other opportunities for programmatic advances are in fixed-target nuclear physics at the AGS. Fixed target experiments would continue the use of the AGS for nuclear physics until the planned Japan Hadron Facility becomes operational, in 2004.

Other Facilities: BNL intends to continue operation of the Accelerator Test Facility (ATF), a unique users facility for experiments in advanced accelerator techniques. This facility is consistent with DOE's theme of developing Extraordinary Tools for Extraordinary Science. This facility is very important to future advances in

accelerator science crucial to many fields of science, including materials science, biological and medical science, and other areas using various kinds of particle beams as diagnostic tools. We anticipate continued operation of BNL's Linac Isotope Product (BLIP) which produces important specialized radionuclides for medical research, and the NSLS-based Laser Electron Gamma Source (LEGS) photon physics program. We also continue to manage the National Nuclear Data Center, providing quality data on nuclear cross sections and structure to the scientific and technical communities.

Research Staff: Experience over many decades and in many laboratories has established that large user facilities cannot reach their full scientific potential without dedicated on-site scientists who anchor and collaborate in the scientific program, maintaining good accessibility to, and continuity in, the facility's programs. The expertise of the BNL staff covers theoretical and experimental sciences. Their work contributes not only to BNL's facilities but also to comparable facilities located at other DOE laboratories. We will continue to maintain and develop the BNL research staff.

3.3.2 Basic Energy Sciences (KC)

The Basic Energy Sciences (BES) Programs at the Laboratory are lead programs within two themes; Exploring Energy and Matter, and Extraordinary Tools for Extraordinary Science. Several BES research programs contribute to the other themes of Fueling the Future and Protecting the Living Planet. The future direction of the programs is essential to the Laboratory delivering on its Critical Outcomes in Basic Science and Technology, and Premier User Facilities. The programs are essential to the Laboratory's goal of achieving strategic growth through interdisciplinary, comprehensive research collaborations. The following are the primary strategic objectives for the BES programs:

- Enhancing the National Synchrotron Light Source (NSLS) to optimize scientific output.
- Completing activities supporting the future decision for the High Flux Beam Reactor (HFBR).
- Conceiving, developing and constructing the next generation light source.
- Participating in development of the next neutron source.
- Bridging disciplines to create research collaborations that provide complete cost effective solutions to regional and national energy issues.

NSLS: The major portion of the BES funding at BNL supports synchrotron and neutron user facilities. It is essential to have a roadmap for these facilities. The Basic Energy Sciences Advisory Committee (BESAC) on the national and regional needs for photon and neutron sources (November 1997) strongly supported the program at the NSLS, and recommended substantial increases in the budget and a continuing investment to keep the facilities at the state-of-the-art. The Committee emphasized the large breadth and depth of the research done at the NSLS, and the fact that the NSLS hosts more than 50% of the users nationwide even though the Advanced Photon Source is well along with its user program. The Committee recommended a substantially increased annual budget for operations. Additional funds were recommended to modernize and upgrade the

facility and the Participating Research Team beamlines at the NSLS. The Committee recommended support for the proposed Phase III upgrade project (see Sections 4), and funding for the "fourth generation", free electron laser sources.

BNL will continue to enhance the performance of the NSLS storage rings, bring on line new beamlines, and upgrade existing ones. By the end of 1998, a complete suite of six infrared beamlines will be commissioned to cover the full wavelength range, and accommodate special applications in microspectroscopy, high-pressure studies, and biomedical spectroscopy.

As with all major large user facilities a renewal plan is in place. It involves upgrade projects every decade to keep the facility at the cutting-edge of science and includes major enhancements in both the accelerator and storage rings, and the beamlines. The centerpiece of this program is a new initiative, the Phase III Upgrade Project. Many beamlines with strong scientific programs are presently suffering from outmoded optics and monochromators. The NSLS also has demonstrated the feasibility of using in-vacuum, small-gap undulators to provide brighter X-ray beams on synchrotrons operating at 3-4GeV. While the Phase III upgrade will provide the needed improvements for the next decade, plans are also being developed for a Phase IV. Phase IV would use B-factory technology to increase the flux in the NSLS X-ray ring.

The final element in the roadmap for photon sources is the development of fourth generation sources. These will likely be active particle-photonic devices i.e., accelerators based on the interaction of electron and photon beams or free electron lasers. In the R&D program at the NSLS BNL is developing the technology and testing the theories of Free Electron Lasers (FEL). The national plan calls for conducting the R&D needed to propose construction of an FEL user facility operating in the x-ray region.

High Flux Beam Reactor: The roadmap for neutron sources will depend on the Secretary of Energy's decision on the High Flux Beam Reactor (HFBR). BESAC reviewed the scientific program at the HFBR (November 1997) and concluded that "the High Flux Beam Reactor at Brookhaven National Laboratory be restarted as soon as possible, to minimize the effect on neutron science research in the United States." They also recommended proceeding with a full Environmental Impact Statement and providing BESAC the opportunity to review the implications for neutron-based research in the United States, if the HFBR was not restarted. An earlier BESAC review emphasized the need to dramatically increase cold neutron facilities in the United States... "BESAC recommends that a conceptual design for the High Flux Beam Reactor upgrade be initiated as rapidly as possible, to establish a firmer cost basis. If the total cost remains as estimated, then DOE should proceed with the HFBR upgrade project as a cost effective method to provide needed cold neutrons scattering facilities." Studies of the aging of the thermal shield have since solidified the project costs.

Until the Secretary of Energy decides, plans for the HFBR beyond the year 2000 are undefined. If it is restarted, it should be possible to operate at 30 megawatts (MW) initially, with a return to 60MW operations by 2001. This would provide enhanced research capability. Restart of the HFBR does not solve the national need for a substantially larger cold neutron capability. Under the restart scenario, when funding for the Spallation Neutron Source (SNS) at Oak Ridge National Laboratory (ORNL) declines, a full upgrade of the HFBR should be considered to provide a new vessel, cold source, and guide hall. If the HFBR is not restarted, another option consists in building a

special purpose spallation neutron source using the AGS. With its existing high peak beam power and reliability, it would be equal or superior as a cold neutron source to any spallation source. BNL is involved in several key areas in the construction and operation of spallation neutron sources through the design and construction of the accumulator ring and beam transport for the SNS.

***Materials Science*:** Several new directions are being pursued in the materials science programs. The fundamental problem of charge transport in highly correlated electron systems, so-called "bad metals," is being addressed by measuring their low frequency dynamics using new infrared spectrometer facilities at the NSLS and comparing the results with models for highly correlated systems developed by the condensed matter theory group at BNL. In collaboration with the University of Connecticut, another program explores the technique of pulsed laser deposition for the in-situ synthesis of important oxide systems such as those exhibiting large magnetoresistance effects. The same samples can be studied at the NSLS by high-resolution angle-resolved photoemission, spin-polarized photoemission, x-ray diffraction and magnetic and inelastic x-ray scattering techniques. This wide array of measurements on well-controlled materials can be reliably compared to recent theoretical models.

A new program for studying nanostructured polymers was submitted to the Materials Science Division of BES. It focuses on the structure-property relationship of supramolecular materials, including intrinsic polymers, polymer blends, gels, and organic/inorganic nanocomposites. A fundamental knowledge of their structure will allow control of crystallization, adhesion, fiber drawing, wetting, and crack propagation. This is a collaboration with the State University of New York at Stony Brook (SUNYSB), and EXXON, and will rely heavily on new x-ray scattering capabilities at the NSLS and the Advanced Photon Source (APS), in addition to neutron scattering facilities.

Nanoscale structure and structural defects in advanced materials such as high temperature superconductors and high strength permanent magnets will be explored using the new transmission electron microscope facility. These studies will be coupled with positron annihilation spectroscopy and computer modeling to explore the role of grain boundaries, vacancies and impurities in the properties of these materials.

***Chemical Sciences*:** New research programs in chemical sciences include the Center for Radiation Chemistry Research, a coordinated program in catalysis and interfacial chemistry, a program on radical-radical reaction kinetics in combustion, and a Center for Spectroscopy in molecular science. A new 10 MeV electron accelerator facility is the core of the radiation chemistry program, for research on picosecond pulse radiolysis, high-pressure radiation chemistry, and combined radiolysis-laser photolysis allowing us to explore very rapid chemical reactions during catalysis and energy conversion and storage.

The coordinated program in catalysis will combine measurements of the atomic and electronic structures of species adsorbed on the surface of catalysts, of the structure of the catalysts, and the photofragmentation of the species and provide an integrated picture of catalytic reactions. The most important questions about combustion are product identification, branching ratios, and reaction rates between two free radicals. The radical-radical reaction kinetics program will use laser photolysis and discharge-flow production of molecular radical reactants and time-resolved mass-spectroscopic product sampling to obtain a detailed understanding of combustion processes.

The goal of the Center for Spectroscopy is to understand important elementary chemical and physical processes in the combustion of fossil fuels. High resolution, high-sensitivity laser absorption methods will be combined with theoretical and computational work using time-dependent quantum wave packet calculations for energy flow and chemical bond cleavage in the radicals.

Energy Biosciences: Our work in Energy Biosciences relates to three of the four themes, namely, Exploring Matter and Energy, Protecting the Living Planet, and Fueling the Future. We will build on the strengths of our programs and focus more closely on meeting the DOE's objectives. We are helping to coordinate the worldwide effort to sequence the rice genome. Basic research on structure-function relationships in lipid desaturases promises to allow the engineering of plants to produce economically important oils and chemical feedstock. Basic studies of plant energetics and membrane transport will find application in bioremediation.

3.3.3 Biological and Environmental Research (KP)

The Laboratory's work for the DOE's Office of Biological and Environmental Research (OBER) focuses on basic and applied research spanning the realm of molecular to macro phenomena, from the structure of proteins and the sequencing of genes to carbon sequestration to systems for environmental remediation. Our work is directly related to the themes of Exploring Energy and Matter, and Protecting Our Living Planet. BNL's unique research facilities offer a myriad of opportunities for understanding the smallest to the largest or most complex problems.

The Laboratory's objectives for these programs are as follow:

- To develop a comprehensive approach to solutions for global change and carbon sequestration.
- To develop interdisciplinary efforts to devise practical solutions to environmental problems.
- To expand our collaborative efforts, focusing on the link between environment, health, and the molecular basis of life.
- To fully utilize our unique facilities and capabilities to address issues of human health.

Environmental Processes: With global climate change and carbon management assuming national priority, three BNL programs will have new emphasis within DOE. The Free-Air Carbon Dioxide Enrichment (FACE) program involves developing and using facilities that expose ecosystems to elevated levels of CO_2 in a controlled fashion. Chemistry and Microphysics of the Troposphere establishes an understanding of the chemical and physical processes that determine the fate of energy-related pollutants emitted into the atmosphere. The Atmospheric Radiation Measurement (ARM) program measures atmospheric radiation and the factors, which control it. The large data sets are stored and analyzed at the ARM External Data Center located at BNL.

In the next three to five years BNL will expand its participation in environmental research in response to the President's Climate Change Technology Initiative and efforts to meet the goals of the Kyoto Protocols. For example, a major new proposal, the

Environmental Carbon Observatory (Section 4) will integrate several disciplines at BNL and elsewhere. It will combine FACE experiments with carbon dioxide eddy-flux measurements in a worldwide network, and integrate measurements of marine carbon flux into modeling of global climate change.

Our environmental studies will profit from the Center for Data Intensive Computing proposed by BNL. (Section 4). In establishing the Scientific Simulation Initiative, the DOE identified Global Climate Change as a key problem requiring near term advances in computational science. One aspect of our proposed program is to address the management and integration of large disparate data sets into a continuum of local to global models of climate prediction.

Two important programs in marine science completed their missions: Inorganic Carbon Measurements for the World Ocean Circulation Experiment, and the Ocean Margins Program. BNL is seeking new collaborations with the Marine Sciences Research Center at SUNY-Stony Brook and with Batelle-Duxbury Marine Laboratory to extend our capabilities to work for other federal agencies and industry.

Environmental Remediation: Our specialty is bio-remediation of soils and sediments contaminated by metals. We plan to grow this area in response to DOE's new program emphasis on microbial phenomena (Natural and Accelerated Bioremediation Initiative Research (NABIR), with upgraded laboratory facilities and an infusion of new staff. In our first NABIR program we are applying our capacity for microbial genome sequencing, biochemical analysis, and genetic engineering to bioremediation in order to analyze a bacterium that can precipitate uranium. Additional proposals respond to the most recent NABIR program announcement.

A new Environmental Management Science Program (EMSP) project studies the chemical modifications of radioactive waste caused by radiolytically generated nitrogen dioxide and peroxynitrite. We plan to increase our involvement in the EMSP and have submitted several collaborative proposals in the most recent calls.

Life Sciences: BNL has an extraordinary combination of strengths in molecular genetics, structural biology, genomics, and biotechnology. This highly interactive research environment is the ideal incubator from which complex user facilities for structural biology can be developed and optimized for the wider research community. These facilities include stations for x-ray crystallography, time-resolved X-ray scattering, and ultraviolet circular dichroism at the NSLS; stations for small-angle neutron scattering, membrane scattering, and neutron crystallography at the HFBR; the high-resolution Scanning Transmission Electron Microscope (STEM) facility, and the Protein Data Bank (PDB), the world-wide archive and distribution center for three-dimensional structures of biological macromolecules.

Demand for our facilities for structural biology is strong and growing. Additions and access to the Protein Data Bank continues to increase rapidly, and we continue to implement web-based tools to increase the utility and access. BNL is submitting an application to continue managing the PDB for the next five years. Demand for access to synchrotron protein crystallography has increased rapidly, and we now partner with outside groups who invest to upgrade our current beamlines and to instrument additional beamlines.

The Human Genome Project will continue to focus on improving vectors for and optimizing a nested deletion strategy for sequencing highly repeated regions of human

DNA, improving capillary electrophoresis for DNA sequencing, to increase read lengths, and improving computational tools for DNA sequencing and validating the quality of nucleotide sequences. We are piloting a project in functional genomics to express proteins from cloned coding sequences of representatives of protein families identified by genome sequencing and to determine their three-dimensional structures. Our combination of capabilities and facilities is ideal for advancing this concept and we plan for a substantial program at BNL, in collaboration with neighboring universities and other DOE Laboratories.

Additional scientific staff and expanded collaborations with the University at Stony Brook for research and training in bio-informatics and computational biology are planned. We were invited to submit jointly with Stony Brook and Cold Spring Harbor Laboratory an application to the Burroughs Wellcome Fund for a Training Program in Computational Biosciences, which is meant to attract graduate and postdoctoral students from physics, chemistry, mathematics and computer sciences to problems in biology that will benefit from an interdisciplinary approach.

Biomedical: BNL's biomedical programs are linked to two themes of Energy Research: Exploring Matter and Energy and Protecting the Living Planet. The programs use BNL's unique facilities and expertise for application in diagnosis and therapy of cancer and diseases of the brain. Nuclear technologies and radiopharmaceuticals are used to develop new treatments, new diagnostic tools and to study human physiology and the mechanisms of disease.

We will expand Boron Neutron Capture Therapy (BNCT) to other types of tumors and develop compounds with better properties. In imaging, we plan to expand our programs to evaluate the function of brain related genes, and gene therapies. We also look to increase the role of the Laboratory in developing medical instruments with unique medical applications, such as accelerators as alternative source of neutrons, small synchrotrons, and detectors with better imaging properties.

BNL has been successful in obtaining funding from other federal agencies. The Laboratory will continue to work with other agencies, such as the National Institute of Health (NIH) and the National Science Foundation (NSF). The development of the Center for Data Intensive Computing (Section 4) will further the success of our Imaging Center for Neuroscience. This Data Center will provide us with critical capabilities, ranging from integration of information derived from PET or Magnetic Resonance Spectroscopy (MRS) images with those derived from Magnetic Resonance Imaging (MRI) spatial images, to ways to represent graphically, information derived from the imaging studies (e.g., functional coherence maps).

3.3.4 Other DOE Programs

The Laboratory conducts science and technology programs for several other DOE Offices, working on energy resources, safety and environmental protection and national security.

BNL intends to expand these programs focusing on national energy issues arising from deregulation of utilities and fulfillment of the Kyoto agreement, the need for safe, clean energy use, and global security issues associated with diversion or theft of nuclear, biological and chemical weapons.

A new initiative on Energy Resources (Section 4) focuses on potential sources for clean, efficient energy. One potential is fuel cell catalysts, and another is new approaches to nuclear energy, both may reduce and control emission of greenhouse gases.

BNL is also proposing to expand its role in energy assessments in the Integrated Energy-Economic-Environmental Assessment and Policy Support Initiative (Section 4). This initiative builds on work developed at BNL, combined with private sector contributions, to create partnerships that will address a range of analytical options and technical solutions to issues defined by the public debate on global climate change and carbon management, and environmental security planning.

Our work in geothermal energy for the **Office of Energy Efficiency and Renewable Energy (EE)** is expected to continue and will be closely coordinated with private sector investments in geothermal development. Similarly work on fuels and buildings will continue, while the photovoltaic program will emphasize DOE's Million Roof Program, a combined government and industry program to put solar or photovoltaic panels on one million roofs in the United States.

For the **Office of Fossil Energy (FE)**, our program on biochemical upgrading of petroleum will begin the transfer to industry. A joint DOE-industry program with a start up company, BioCat, will commercialize the process. We will pursue funding to use our expertise in microbial genetics and biochemistry to advance our understanding of the molecular bases for desirable microbial actions. In response to DOE's interest we are developing a new program in methane gas hydrates involving a combination of biological and low temperature catalytic processes.

BNL will continue to support the **Office of Nuclear Energy, Science and Technology (NE)** in its role in the United States program on enhancing the safety of Soviet design power reactors.

DOE's new approach to nuclear energy R&D, developed by the Office of Nuclear Energy, Science and Technology (NE), has two elements that are aligned with BNL expertise -- the Nuclear Energy Research Initiative (NERI), and the Nuclear Energy Plant Optimization (NEPO). BNL has two efforts that address this initiative (Section 4). Our proposal under NERI involves the potential use of Th and U-235 fuel in light water reactors. For NEPO we will work in Age Management and High Burn Up Fuel.

In work for the **Office of National Security (NN)**, global security opportunities are growing for BNL. This work includes safeguarding Russian special nuclear materials, providing technologies to the United States to support treaty verification, and to detect and respond to events associated with weapons of mass destruction (international and domestic situations). Our special capabilities include novel detection devices, software, risk analyses and training. We assume overall project management and coordination responsibilities, where appropriate, and create teams including other National Laboratories, universities, and the private sector, thereby providing the entire solution to a particular problem being addressed.

We will continue our partnership with scientists in key institutes in the Newly Independent States of the Former Soviet Union to develop technologies appropriate for commercialization, under the Initiatives for Proliferation Prevention (IPP) program, to stabilize the technology base and to prevent and reduce proliferation of weapons of mass destruction.

We will continue work on detecting and preventing attacks from chemical and biological weapons. Currently we are funded to develop state-of-the-art sensing capabilities that can be used for inspection, surveillance, and response to terrorist actions. We will also continue our investigation of pathogenic genomic indicators for detection and speciation and the characterization of the structure and function of a number of biological toxins. This work is in direct support of recent Presidential and Congressional initiatives relating to U.S. Domestic Preparedness against Chemical and Biological Terrorism.

Through funding from the DOE **Defense Programs Office (DP)**, we are supporting the Accelerator Production of Tritium Office at Los Alamos National Laboratory (LANL). There will be a selection in the APT program later, in FY 98, of either the accelerator approach or a light-water reactor approach which may affect our future involvement. Other work related to safety functions and responsibilities at Defense Program (DP) facilities and verification of integrated management systems, and work to assist the Russians in decommissioning of nuclear submarines also is scheduled for completion late in FY 1998.

We expect continued support from the **Office of Environment, Safety and Health (EH)**, for technical assistance in safety review and standards development. The Marshall Islands program sponsored by EH is evolving toward alternative analytical technologies. Similar work is now being supported by the Department of Defense. In collaboration with Battelle and other public and private sector customers, we will seek additional support for the capabilities developed at BNL.

A downturn in support from the **Office of Environmental Management (EM)** for BNL's waste technology programs requires us to focus our business development on multiple sponsors. We will continue to work with BSA's two prime subcontractors, Bechtel and Waste Management Federal Services, to support cleanup efforts at the Brookhaven site. We also plan to build links with other DOE sites, specifically, Savannah River, Rocky Flats, and Hanford, to use our technologies and expertise for site-specific cleanup. We will continue to offer novel solutions to complex waste problems and work with our industrial partners to develop practical commercial products and services.

A major redirection of DOE's educational mission occurred in FY 1996, with the return of the programs to the **Office of Energy Research (ER)**. We will continue to focus on the college and university programs. The challenges for the future are to maintain momentum generated by our pre-college programs, expand our mission in public awareness of Laboratory activities and reinforce our traditional activities in undergraduate and graduate education. The BNL Office of Educational Programs has developed a plan for the next five years which would accomplish the following:

- Reinforce the University programs by rebuilding the Semester Program with cost sharing from NSF Alliance for Minority Participation Programs at City University of New York (CUNY) and SUNY Stony Brook, re-establish student faculty research support program and develop new undergraduate summer courses, and expand efforts with local institutions to establish a Long Island Council on Undergraduate Research and Engineering.
- Expand the Community College Technical Assistance Program.

- Maintain the key Minority High School Apprenticeship Program and support for undergraduates from the Science in Urban and Minority Schools Program partnership.
- Provide opportunities for NSF support from the Mathematics Science and Technology Program for the pre-college teacher enhancement programs, focus on developing summer and academic year research and science opportunities for pre-service teachers, and re-establish low cost evening graduate courses for local secondary teachers.
- Draw on BNL staff volunteers to continue and expand the School District Technical Assistance Program.

3.3.5 Major DOE Collaborations

Large Hadron Collider (LHC): Brookhaven plays an important role in the LHC Project and its subsequent scientific program. BNL is the host laboratory for United States participation in one of the two large LHC detectors, ATLAS, and manages the U.S. contributions to this detector, preparing U.S. scientists for collaborations in the LHC's physics research program. BNL is also a member of a three-laboratory team that manages the U.S. contributions to the accelerator part of the LHC Project. BNL will test all the LHC superconducting cable and produce a set of RHIC-type superconducting magnets for the LHC machine lattice.

Muon Collider: Three potential technologies were identified as possible successors to the LHC: linear electron-positron colliders, muon colliders, and very large hadron colliders. The world's high-energy physics community will vigorously pursue R&D to refine the technical merits of these technologies, and to characterize their costs and scientific applicability to the next generation of research in particle and nuclear physics. BNL will intensify its efforts in muon collider R&D. A multi-institution Muon Collider Collaboration, initiated in 1997, has a BNL spokesperson, and we are consolidating the group's efforts in a more directed program of exploratory R&D, employing a project management approach. The DOE indicated that it will support this approach; it will be incumbent upon BNL to ensure its realization.

Fourth Generation Particle-Photonic Devices: In the R&D program at the NSLS, BNL is developing the technology and testing the theories of Free Electron Lasers. Several demonstration experiments are in progress at the Accelerator Test Facility (ATF). BNL demonstrated Self Amplified Spontaneous Emission (SASE) at a wavelength of 1 micron. A collaboration with the Advanced Photon Source at Argonne National Laboratory (ANL) uses the "Chess Undulator" to follow SASE to saturation, and to test seeded-beam operation and the concept of High Gain Harmonic Generation (HGHG). This will be followed by a collaborative experiment at the ATF with UCLA, Stanford Linear Accelerator (SLAC), Los Alamos National Laboratory (LANL), and Lawrence Livermore National Laboratory (LLNL) to make a detailed comparison between theory and experiment at visible wavelengths. The wiggler used will become part of a prototype FEL operating between 200nm and 50nm, a wavelength five times shorter than before. This DUV-FEL is discussed as a new initiative (Section 4).

Spallation Neutron Source (SNS): BNL is involved in several key areas in the construction and operation of spallation neutron sources. BNL is responsible for the

design and construction of the accumulator ring and beam transport for the SNS. An international team will use the AGS for R&D on targets for future spallation sources. The intense proton beams and very short spills available from the AGS can provide the instantaneous power levels that a spallation target of several megawatts would experience, with the attendant shock-wave and thermal stresses. Successful experiments were performed on a liquid mercury target in 1997 and a second set of experiments is planned for 1998. A Spectrometer Development Team spearheaded by scientists at BNL submitted a proposal to build a backscattering spectrometer for high resolution inelastic and elastic scattering at the spallation neutron source at Los Alamos National Laboratory. The Instrumentation Division at BNL is leading the development of novel neutron detectors. They are constructing a detector for another spectrometer at LANL and will build the detector for the backscattering spectrometer.

Global Climate Change and Carbon Management: BNL participates in the multi-Laboratory and University collaborations addressing several key aspects of global climate change and carbon management protocols. BNL leads the FACE program and has a principal role in the ARM program. We are working closely with Pacific Northwest National Laboratory (PNNL), Oak Ridge National Laboratory (ORNL) and Argonne National Laboratory (ANL) to integrate the various tasks in DOE's climate change response, and linking with the other agency participants from National Oceanographic and Atmospherics Agency (NOAA), and National Space and Aeronautics Agency (NASA). National coordination and integration is essential for developing a unified climate change model as proposed as part of the Strategic Simulation Initiative.

ChemBio Program: Under DOE's ChemBio Program, Brookhaven is collaborating with other national laboratories to apply expertise in molecular genetics and structural biology to develop rapid and sensitive detection systems based on genomic information, and to determine the structures of critical toxins and virulence factors as a first step toward developing highly specific structure-based detection systems and protective measures against biological warfare.

International Nuclear Safety Program: BNL is a member of the national Laboratory team headed by PNNL, to ensure the continued safety and orderly shutdown of the Former Soviet State's reactors. The team corrects major safety deficiencies and establishes nuclear safety infrastructures that will be self sustaining. More than 150 joint projects have been initiated at nuclear installations. BNL's focus will continue to be in the areas of training, simulator development, safety system upgrades, fire hazard analysis, and technology transfer.

3.3.6 Economic Development and Technology Transfer

An important strategy of the DOE within its Science and Technology Mission is to pursue partnerships with industry, academia, and other federal agencies, that will proactively transfer technologies from the Laboratories to industry. One of DOE's objectives is to increase the number of feasible and demonstrated technologies that are commercialized.

BNL has two primary objectives for its economic development and technology transfer program. First, the technology transfer projects conducted by the Laboratory will complement our research mission and will enhance our capabilities to perform research

on behalf of DOE. Second, the technology transfer program will make it possible for BNL developed technologies and technical capabilities to become resources for United States industry to enhance competitiveness in domestic and international markets. Local and regional economic development is a part of this goal. Several technology transfer mechanisms are employed including industry use of Brookhaven's world class designated user facilities, sponsored research, cost-shared research projects under Cooperative Research and Development Agreements (CRADAs), intellectual property licensing, and personnel exchanges.

The Laboratory's work for non-federal program sponsors, under which Brookhaven performs research for industry, universities, non-profit sponsors, and state and local government, is of great significance for technology transfer. We anticipate more interactions with the medical products and health community, New York State utilities, the environmental industry and the electronics industry in our region, as a result of our growing relationship with SUNY Stony Brook Centers for Advanced Technology, New York State's Energy Research and Development Agency (NYSERDA), and New York's Power Authority (NYPA).

BNL will increase Cooperative Research and Development Projects with industry, and we will expand the Intellectual Property Licensing Program. Brookhaven Science Associates (BSA), the contractor-operator of Brookhaven, has the right to take title and patent rights to technologies invented by Brookhaven employees at the Laboratory. Examples of promising technologies that BSA has available for licensing include: (1) biological materials and processes including gene expression systems, DNA sequencing processes, and recombinant plasmids for encoding restriction enzymes; (2) metal primers and coating compositions; (3) environmental remediation techniques, including microbial materials that remove toxic metals from contaminated wastes; (4) radiolabeled monoclonal antibodies for diagnostics and therapeutics; and (5) instrumentation for preparing radiotracers for medical research and clinical applications.

BNL will continue to develop the patent licensing program to effectively foster commercialization of our new technologies. Inventions arising from our biotechnology research programs continue to be of particular interest to industry. Our strengths in medical imaging, radiopharmaceuticals, nuclear medicine, molecular genetics, genomics, structural biology and protein engineering continue to produce new technology that are licensed to industry for medicine and biotechnology. Technology based on our potential T-7 gene expression system continues to evolve, with new patents issuing and new commercial licenses continuing to be put in place. We will seek private investments to accelerate technology development to commercialization, through a contractor-funded commercialization program and incentives to encourage staff to commercialize their technologies (e.g. Entrepreneurial Leave). We will explore possibilities that BNL-developed computer software may have commercial application and be appropriate for copyrighting and licensing. To this end, we have joined the Long Island Software Technology Network (LISTNet), the fastest growing LI industrial network, to ensure our products and services are made available to the area.

3.3.7 Work for Others and Collaborations

The science and technology developed at BNL for DOE sponsors are becoming increasingly valuable to other federal agencies. BNL designated growth in our science and technology efforts for other federal agencies as a Critical Outcome over the next three to five years. We will accomplish this goal by increased interdisciplinary research collaborations that will expand our capabilities in addressing issues of environmental quality, national energy needs, global security and human health.

We are proposing a joint BNL/SUNY of Stony Brook Institute for the Study of Environmental and Public Health (Section 4). This initiative will focus on public health issues related to environmental problems through integrated cause and effect research. We also intend the Institute to interest new scientists in the domestic and international environmental problems and associated health issues.

We are also proposing a Center for International Security (Section 4) which would work to focus at the interface between technology and policy in the area of international security. Part of the Center's mission would be to train and encourage new scientists to work in this critical area. We also will work with DOE and other agencies on critical infrastructure issues, particularly transportation and security, and including assistance to the U.S. Department of Transportation in ensuring its mission in airport security (Total Terminal Security Initiative, Section 4).

The Nuclear Regulatory Commission (NRC) budget has sharply decreased over the past three years and BNL's share in certain areas decreased accordingly. We expect the budget to continue in certain areas. However, in other industries and technologies, as well as in the international nuclear-power community, we see potential growth in the use of our technologies and we intend to exploit this growth area while we maintain our current multi-year programs with the NRC. We also will pursue non-nuclear markets that need the capabilities of our two test facilities, the Combustion Test Facility and the Electric Cable Test Facility (e.g. chemical, aerospace industries).

We will seek increasing support from NIH, EPA, DOD, and DOT in the future, leveraging the unique user facilities at Brookhaven and our expertise. For the Department of Defense, we will expand our work for the Air Force on planar optical displays, and we will initiate work with the Army on chemical and biological defense. For NIH, we expect increasing use of our cancer diagnostic and treatment facilities and expertise. For EPA, the Corps of Engineers and the Navy, we are proposing expansion of our harbor sediments program, in conjunction with the University at Stony Brook and Battelle-Duxbury, and for the Department of Transportation, we intend to use our expertise in human factors and risk assessment, combustion and cable test facilities and the Ramon LIDAR system, to address aircraft safety and airport security problems.

Several of our biomedical centers and facilities, develop or operate through partnerships with, and funding support from other federal agencies or other funding sources. These include our Imaging and Neuroscience Center, the Protein Data Bank, the Scanning Transmission Electron Microscope and programs at the NSLS. This type of partnership and distributed support is important to advance science and technology in the national interest, and we expect it to increase in the coming years.

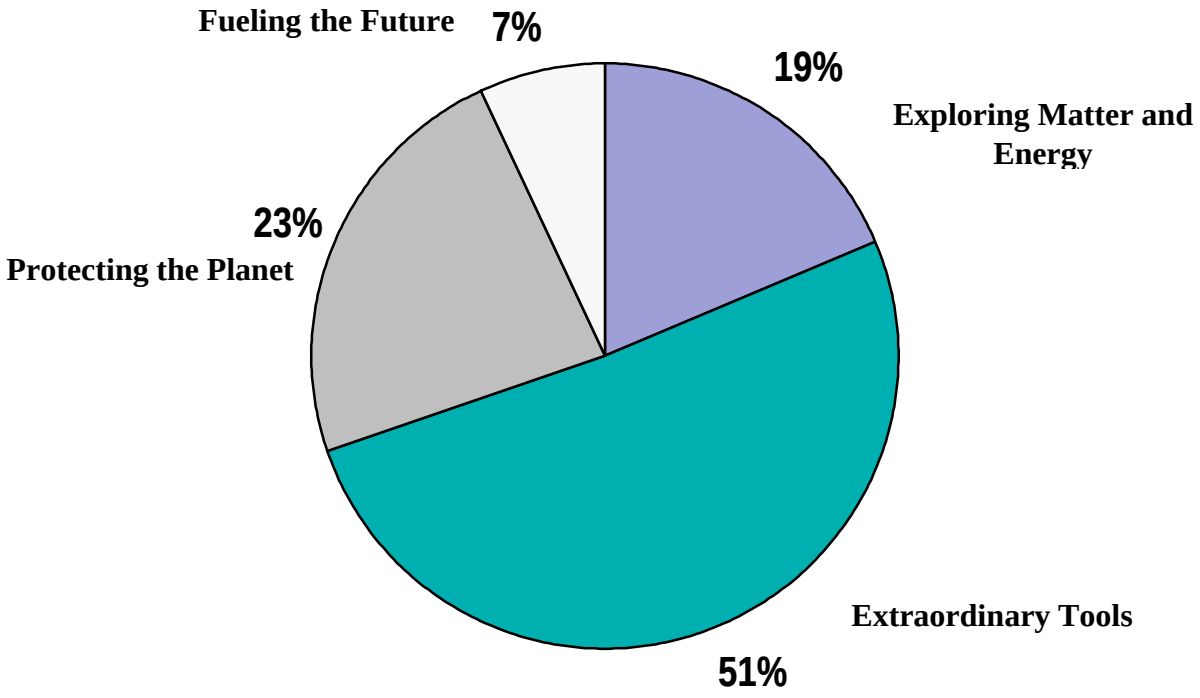
We are actively seeking partnership with the Division of Research Resources and the National Institute of General Medical Sciences of the NIH to develop facilities for

synchrotron crystallography at the NSLS and increase their usefulness to the wider research community. The NIH Division of Research Resources has awarded funds to support technology development and increased user access to a cluster of five protein crystallography beamlines. NIGMS is exploring ways in which their support can increase the efficiency and user access to protein crystallography beamlines at the NSLS.

NIH provides substantial support in the biomedical area through research grants initiated by individual investigators. Such grants currently involve work on DNA damage and repair, protein structure and folding, a viral protease and receptor, and the Lyme disease bacterium. With support from NIH, we will continue our collaboration with the Medical Center at the University at Stony Brook for genomic, biochemical and protein structural analysis of the Lyme disease bacterium and emerging pathogens of regional interest. We will apply this information to develop better diagnostics, vaccines and therapeutics. We plan to search for single-nucleotide polymorphisms in human genes important for recognizing and repairing DNA damage, starting with the DNA-dependent protein kinase and related genes.

Brookhaven's capabilities and staff skills also extend to international work supporting DOE and its sister agencies in transferring technology to friendly nations. Our near-term focus is on the former State of the Soviet Union and reactor safety and nuclear Navy decommissioning. For example, BNL is supporting the EPA Office of International Affairs and DOD in several environmental cleanup activities in Kazakstan. Brookhaven's International Safeguards Project Office (ISPO) supports the International Atomic Energy Agency (IAEA) in nuclear safeguards. Our MARKAL-MACRO computer code is finding increasing use by developing nations to help them design energy efficient infrastructures. This is likely to grow as a result of a partnership with a private firm contracted to the Agency for International Development (AID) to deliver such services.

Figure 1 - Comparison of BNL Activities with DOE Themes



4. Initiatives

We discuss our initiatives under two categories. The first are Laboratory Initiatives that articulate our future vision for Brookhaven National Laboratory and further our overall mission in the long term. These Laboratory Initiatives respond directly to the themes established for DOE's science and technology portfolio, pushing the frontiers of science forward in areas of vital national interest. They will receive the focused attention of the Laboratory Director and the Integration Council, and the support necessary to convince the DOE that BNL is the right place to invest its future resources. A significant fraction of our Laboratory Directed Research and Development (LDRD) funds will be applied to these initiatives.

The second category, Programmatic Initiatives build on and extend our research and technology base. These initiatives respond to developments within BNL and new opportunities presented by DOE, other federal agencies, New York State and industry. They fulfill our responsibility to DOE's mission and respond to the DOE's four themes for science and technology. These initiatives will receive the focused attention of the cognizant Associate Laboratory Directors who are responsible for assembling the interdisciplinary teams and resources to respond to requests for proposals and other program solicitations. The Programmatic Initiatives will be in competition for available funds.

Initiatives are provided for consideration by the Department of Energy. Inclusion in this plan does not imply Department approval of or intent to implement an initiative.

4.1 Laboratory Initiatives

4.1.1 Deep Ultraviolet Free Electron Laser Research Facility (Extraordinary Tools)

BNL proposes to construct a Deep Ultraviolet Free Electron Laser Research (DUV-FEL) Facility as a continuation of the Laboratory's mission to provide extraordinary facilities for advancing science and technology. While the NSLS continues to improve its storage rings to advance synchrotron radiation research, it has become clear that Free Electron Laser (FEL) based sources can provide research opportunities unavailable with any alternative technology. Linac-based FELs promise 12 orders-of-magnitude improvement in peak power over storage rings, as well as access to phenomena at sub-picosecond time scales. The NSLS has long had a program of FEL R&D, and has made significant theoretical and experimental contributions. A major milestone in this program was the January 1994 release of the Deep Ultra-Violet Free Electron Laser (DUV-FEL) Conceptual Design Report (CDR). It details the scientific rationale for an FEL operating in the deep ultraviolet, and describes a user facility designed to meet those needs.

The project's scope and approach were modified to meet the needs of a national program of R&D. This program may lead to the construction of a dedicated "Fourth Generation Light Source" around the year 2005. The DUV-FEL will provide the technical case for developing the source and scientific applications for a true user facility. It will produce sub-picosecond pulses of UV radiation at wavelengths as short as 50 nm and peak power of several hundred megawatts. It will be operated in a chirped-pulse mode producing 4 femtosecond pulses at 88 nm with peak power of 100 GW. The

research opportunities provided by this facility include photochemistry of molecules important in atmospheric chemistry, quantum control of reaction pathways, and non-linear optics studies of inner-shell processes and atomic stabilization. BNL anticipated the need for such a facility, and has invested significant discretionary laboratory resources in advancing the project. The accelerator system is being assembled from existing components.

In a multi-institutional collaborative effort, BNL has developed seeded beam approaches to amplifier FEL design, including sub-harmonic seeding (High Gain Harmonic Generation) and Chirped Pulse Amplification. A significant benefit of the seeded beam FEL approach is that it ensures that the wavelength, bandwidth, and pulse length stability of the incident seed laser are imposed on the FEL output radiation. The ultimate objective is to provide radiation with properties that make it amenable for use as an experimental source. The work done to date will extend the range of FEL operation to wavelengths well below 100 nm, and peak power exceeding 100 GW.

The project's budget projections include monies required to complete the assembly of existing components, to construct the apparatus to use the FEL radiation and to extend the building to house the experiments. Machine developments include enhancements of the amplifier wiggler, an energy upgrade of the linac, and the installation of a high-power high-repetition rate Radio-frequency (RF) driver for the linac. These accelerator elements were included in the original DUV-FEL Conceptual Design Report (CDR), and all are deemed important parameters to explore in order to develop an adequate knowledge base for designing a dedicated 'Fourth Generation' user facility.

A program of research and development was established for the project, and experiments using the radiation from the FEL at various stages in its construction were identified. Investigators from outside BNL have agreed to participate in using the FEL while it is still under development. This close interaction between end-users and source-developers will focus research activities on the properties of the FEL that will be most important for future research.

4.1.2 Brookhaven Center for Data Intensive Computing (Extraordinary Tools)

BNL is proposing an initiative connected to the DOE Strategic Simulation Initiative, the Center for Data Intensive Computing. This initiative will be undertaken in close collaboration with the Computer Science Department at the University at Stony Brook.

Scientific advances in the twenty first century require the effective accumulation and use of extremely large data sets (e.g. climate and meteorological research, RHIC and LHC experimental results, revolutionary advances from research in molecular biology). Data intensive computing is one of the main areas of scientific computing where significant advances are needed to meet national scientific goals.

BNL has a broad based and pressing need for data intensive computing capabilities. The Laboratory proposes a Center of Excellence to address the range of scientific computing needs at BNL and throughout the DOE complex.

- The DOE-Office of Energy Research's national laboratories have the world's largest array of large experimental user facilities: Brookhaven is one of these laboratories. Each year the laboratories host thousands of scientist and engineers from around the world representing academia and industry. Their work generates a large volume of data that must be stored, retrieved, transmitted, merged, then analyzed and interpreted by many individuals.

- Brookhaven's Protein Data Bank contains over 6,000 protein structures representing about 1,000 different folding patterns. Genome sequencing projects are identifying hundreds of protein families for which no functions are known. Computer science and computing capacity will be increasingly challenged to integrate and interpret the flood of information from both genome sequencing and structure.

- The Atmospheric Radiation Measurement Program (ARM) is a major DOE effort to quantify the atmospheric flux of solar and infrared radiation. It maintains large experimental sites in Oklahoma, the Alaska's Slope, and the tropical western Pacific. BNL operates the ARM External Data Center, which collects and prepares for achiving meteorological and other data, such as satellite data. Integrating these data with data from other sources into climate models that can predict climate changes on local to global scales is a major computer modeling challenge included in the DOE's Strategic Simulation Initiative.

- The Imaging Center for Neuroscience at BNL investigates the function of the human brain and its disruption by disease, drug addiction and aging, and develops images with novel information content. These studies are carried out on humans using Positron Emission Tomography (PET), Magnetic Resonance Spectroscopy (MRS) and Magnetic Resonance Imaging (MRI). While enormous advances have been made in radiotracers and in imaging instrumentation, the development of image analysis techniques has lagged behind due to the need for new analytical techniques.

Other areas where computational resources are needed are the physics programs as exemplified by RHIC Physics Simulation and the ATLAS program for the LHC, materials simulation, chemical dynamics, combustion processes, reacting multiphase fluid flow, environmental modeling, microtomography, and accelerator design, including particle beam interactions.

Simulations of combustion and materials have the potential to impact the nation's energy use by their contribution to development of more energy efficient systems. These are likely to be part of the Strategic Simulation Initiative and we expect to play an important role in these endeavors.

Significant investments in computational science and information technology will be required to build and staff such a Center at BNL. BSA and BNL are fully committed to this effort; the partnership between SUNY Stony Brook and Battelle brings a wealth of expertise in mathematics, engineering, data handling and visualization to the Laboratory. Furthermore, partnerships with other laboratories, universities, and the private sector both regionally and nationally are critical. Already, we play a pivotal role in the DOE's "Grand Challenge" on computing at Lawrence Berkeley National Laboratory (LBNL) and are members of the LI software industry's network, LISNET.

Between BNL and Stony Brook, we envision a core group of 20 computer scientists in the Center, led by a nationally known expert, whom we will recruit this year. The center will need to provide a network infrastructure sufficient to communicate large sets of data between experimental facilities and data analysis centers, data storage warehouse with terabyte online storage capacity and multi-terabyte nearline storage, and local computationally intensive systems to perform software development work, provide cycles for scientific simulations, analyze experimental data sets, and aid in the visualization of analyzed data.

We invested in a new 3-D stereo imaging facility developed as a part of a CRADA with Mobil Oil. It provides high resolution stereographic viewing of computer generated "data images" for up to 20 people at one time.

A detailed proposal will be developed based on these concepts in response to DOE's planned Scientific Computing Initiative, scheduled to start in FY 2000.

4.1.3 The Environmental Carbon Observatory (Protecting the Living Planet)

An Environmental Carbon Observatory (ECO) is proposed which will measure the carbon dioxide flux from terrestrial sources around the world and provide critical input to models of global change and protocols for carbon management (sequestration). This observatory will complement the DOE's investment in Atmospheric Radiation Measurements, which provides critical input on the flux of solar and infrared radiation in the atmosphere.

The terrestrial biosphere is the primary driver for the annual variability in the atmospheric inventory of carbon dioxide over periods of years to centuries. It is not possible to predict future concentrations of carbon dioxide with reasonable precision because it is not known how the biosphere will interact with a changed global environment, for example, one with higher carbon dioxide concentrations or higher temperatures.

The proposed ECO initiative calls for the integration and expansion of two DOE/OBER facilities-based programs, Ameriflux and FACE, to focus on reducing uncertainties in predicting carbon sequestration and future atmospheric CO_2 concentrations. Linking the Ameriflux and FACE sites is crucial to obtaining ecosystem responses to further climate change scenarios. Eddy flux measurements provide constraints on process level models derived from FACE. FACE models provide a way of projecting net ecosystem exchange in the future. A significant new opportunity in science for BNL will be in developing the analytical modeling framework that will be needed to integrate across temporal and spatial scales in building products for research sponsors.

Although we presently have the ability to measure carbon flux and net ecosystem production (NEP) for 40 eddy-covariance tower sites in the Ameriflux and Euroflux programs, we cannot actually quantify spatial heterogeneity of either CO_2 flux or NEP at these sites. Thus, statistical extrapolations to large areas carry confidence bands that are poorly defined. We have FACE facilities in several types of ecosystems that are intended to provide a means for predicting how those ecosystems will respond to increasing atmospheric CO_2, and how carbon storage in those systems might change. None of the FACE sites has well-developed modeling components that will allow the findings of the

experiments to be coupled to regional analyses of carbon sinks or prediction of regional, ecosystem-level responses. Furthermore, the ecosystems studied are a poor representation of the variability of the biosphere of our planet. Eddy flux tower measurements and FACE experiments have great potential to provide the tools needed to both monitor planetary carbon flux and predict biospheric responses to climate change, if they are augmented and integrated in a coherent program. In this way, well-bounded predictions of both carbon sequestration and atmospheric CO_2 may be obtained.

ECO will be the first large-scale user facility developed for ecosystem-scale manipulative experiments in the field. With a focus on climate change and carbon sequestration issues that are central to DOE interests, ECO can provide both basic and applied science to meet the programmatic needs of sponsors. The scope of science that can be accomplished with ECO is a consequence of the large plot size that can be accommodated by FACE and the large "foot print" of an eddy flux tower. These features allow dozens of scientists to collaborate in experiments at the same site on topics that range from molecular-level controls on proteins regulating photosynthesis, through ecosystem-scale controls on carbon sequestration in forest biomass and soils, to linkages via gas exchange with the planetary boundary layer. In combination with other aspects of the US Global Change Research Program, we will be able to model global carbon sequestration and atmospheric CO_2 from the process level upward.

We propose to develop the Environmental Carbon Observatory using elements of current OBER programs as the base. In particular, the Ameriflux and FACE programs are central to the concept. This new initiative will require substantial funding in the following four areas: facility development, facility operations, and a dramatic increase in the funding of research on the terrestrial carbon cycle. The ECO initiative also requires a training program for the personnel that will operate the facilities and to conduct the science. Under ECO several dozen observatory facilities would be constructed in ecosystems around the world. Each unit consists of a central intensive core, including a set of eddy flux towers and FACE experiments, and an extensive set of eddy flux towers and aircraft over-flights, so that the behavior (and variance) of each large region of the terrestrial biosphere is quantified.

Global-scale analysis based on ECO will require the ability to integrate research across spatial and temporal scales. BNL is in a good position to capitalize on our present activities and connections. Within the FACE program, models are being developed that describe quantitatively the linkage between repression of gene expression controlling Rubisco activity due to elevated CO_2, to leaf-level net photosynthesis. BNL researchers are playing the leading role in this aspect of the science. A second modeling effort takes leaf-level gas exchange measurements of photosynthesis and other variables and provides estimates of net production of the forest canopy, and BNL is participating in this effort. A third modeling effort links canopy gas exchange to the flux of energy, moisture and CO_2 between the forest and the atmosphere, another area in which BNL participates. All of these are presently independent efforts. A particularly important opportunity that ECO will create is the ability to provide explicit modeling linkages across these temporal and spatial scales. By strengthening our capabilities in terrestrial ecosystem modeling, and developing an integrated framework for modeling across these scales, BNL also will be in a position to play the leading role in production of research products requiring integration of information from many semi-independent users of the ECO facility.

4.1.4 Human Proteome Project (Exploring Energy and Matter)

The entire set of proteins specified by the genome of an organism is referred to as its proteome. The known proteomes for free-living, single-celled organisms range from several hundred to more than 6,000 proteins. The human proteome is estimated to have 60,000-100,000 proteins.

To understand the human proteome, we need protein structures for the range of protein families found in nature, and the informatics and computation tools to take advantage of this information. Such developments are also widely applicable to other DOE missions, including the Microbial Genome Project and the use of microbes, plants, or enzymes in bioremediation or industrial processes that increase the efficiency or quality of energy production.

The Human Proteome Project will be a large-scale, multi-disciplinary, cooperative effort involving National Laboratories, universities, and industry. BNL proposes that the Laboratory serve as a center for producing proteins and determining structures. The NSLS is one of the most efficient of the synchrotrons that is the workhorse of structure production. We expect that DOE, as steward of the National Laboratories and synchrotron sources, will play a prominent role, in partnership with NIH and others for this large-scale enterprise. The Human Proteome Project could have an impact comparable to that of the Human Genome Project.

As a start to this massive post-genome project, BNL is piloting procedures for cost-effective large-scale structure determination by protein crystallography, starting from known coding sequences. Our results are very encouraging. Once routine procedures are established, we will put each protein through a standard crystallization screen set up robotically at BNL, and distribute purified proteins with evidence of crystal formation to crystallographers who will optimize the crystallization and freezing conditions. Diffraction data for solving the structures will be collected at the protein crystallography stations at the NSLS.

In this initiative, we propose that BNL produce crystals suitable for structure determination which, together with continuing improvements in the protein crystallography beamlines at the NSLS, will provide the capacity to produce structures rapidly for a range of protein families and at a fraction of the current cost. To do this effectively, we must strengthen our capabilities in bioinformatics and computational biology and increase our efficiency in and capacity for determining protein structures by crystallography. A dedicated crystallography beamline at NSLS will be needed, as well as increased effort from beamline scientists and crystallographers to improve the efficiency of solving, refining, and annotating structures.

4.2 Program Initiatives

4.2.1 NSLS Phase III Upgrade (Extraordinary Tools)

The Phase III upgrade is fully aligned with DOE's goal of providing and maintaining our national assets for interdisciplinary research. The NSLS is one of the DOE's critical research facilities to explore simple and complex systems. This initiative maximizes the scientific output of the facility and is essential to meeting our critical objectives.

The initiative includes upgrades to two of the 25 beamlines on the UV ring. These beamlines support strong scientific programs but produce less than optimal science because the monochromators are outdated. The increased photon energy resolution resulting from upgrades will support state-of-the-art electron spectroscopies (e.g. high electron energy resolution angle-integrated photoemission). The flux at the sample will be greater, at a given photon energy resolution, because there will be no need to mask the optics. The superior optical design of the new monochromators and the superior figure and finish of the new gratings and mirrors ensure that radiation from the ports on the VUV ring is fully accepted.

Eight of the 60 operational beamlines on the X-ray ring will be improved, taking advantage of improvements in x-ray optics and detectors. X-ray mirrors will be replaced on the most productive and well equipped beamlines of the 2.8 GeV ring, used for X-ray spectroscopy, X-ray scattering for chemical and materials sciences, biostructural studies and x-ray imaging.

Improvements to the machine will focus on photon beam position monitoring systems for UV and X-ray, new rf cavities/transmitters and three insertion devices for the X-ray storage ring. High resolution monitors (< 1 micron) will be added to each available port on the machines to independently measure the position of the photon beam as it is delivered to the user.

Four 52.88 MHz cavities on the X-ray storage ring have water-to-vacuum welds, which are a potential problem. Two of the four are being replaced. The remaining two will be replaced by this initiative. Two additional transmitters will be added to reduce the likelihood of beam loss or fluctuation.

Two new X-ray undulator sources will be added and the associated beamlines constructed. These new undulators are based on successful R&D efforts on insertion devices and our experience with a prototype in-vacuum small gap undulator developed in collaboration with Spring-8. One of the new lines may be dedicated to protein crystallography. New insertion devices also will be installed on X25, halving the gap and period of the existing device, and increasing the brightness by a factor of two without adding heat load on the x-ray optics.

A superconducting magnet energy storage system (SMES), developed for the U.S. Air Force, is undergoing tests on the UV ring. If the tests are successful, a larger unit will be obtained for the X-ray ring. This will reduce the unscheduled downtime caused by voltage transients on the Laboratory's power feed.

The conventional construction included in the Plan III upgrade is a 9,400 square foot second floor over the X6 – X16 area of the NSLS, providing space for offices and a

conference room. It also includes 6,300 square feet of open space that will be developed by the user community.

4.2.2 Expansion of Protein Crystallography at the NSLS (Extraordinary Tools)

Demand for access to synchrotron radiation for protein crystallography has been accelerating and continues to outstrip availability. With awakening interest in high-throughput determination of three-dimensional structures of all of the protein folding domains represented in nature, demand for more capacity for synchrotron crystallography, state-of-the-art instrumentation, semi-automated beamline operation, and highly efficient structure-solving software will increase even more rapidly. The NSLS is arguably the most reliable and economical source of x-rays for protein crystallography, and is ideally placed to satisfy much of the increased demand.

Beamline scientists of the Biology Department and the NSLS are world leaders in developing user-friendly and efficient synchrotron beamlines for protein crystallography. A core group of scientists and technicians constructed and operates two bending-magnet beamlines and a wiggler beamline (available half time) for protein crystallography, and is collaborating with the PRTs of two additional beamlines to provide technical and operational support in return for a portion of PRT beam time for the general user program. In these collaborations, the PRT pays to equip the beamline and provides some operational support, and BNL scientists provide technical and operational support needed to make the beamline highly efficient. Through support from OBER, BES, NIH and the outside PRTs, we are bringing these five beamlines to state-of-the-art reliability and efficiency, with modern CCD-based detector systems, and are exploring new technologies to improve their effectiveness and efficiency. With additional support, through an emerging partnership between OBER and NIH, we will construct and operate additional beamlines for protein crystallography and explore new operational methodologies that could eventually replace most of the traditional, expensive visits of teams of crystallographers to synchrotrons to collect data.

4.2.3 RHIC Physics-Simulation (RPS) (Extraordinary Tools)

In 1999, the DOE's newest facility for advancing the theme, "Exploring Energy and Matter" will begin operations at BNL. The Relativistic Heavy Ion Collider will be an extraordinary tool in the field of nuclear physics.

Exploration of the physical properties of quark gluon plasma, the state that characterized the early universe a few microseconds after the "big bang," is a major research area for experimental physics at RHIC. Other areas include the possibility of "strange matter," a special state of nuclear matter that may still be present at the core of some white dwarf stars, and basic asymmetries in fundamental processes that are revealed by the presence of quark and lepton spins and their behavior in subnuclear interactions.

Research at the RHIC facility will require handling a vast amount of primary data and computing resources of unprecedented power and capability. To understand the full complexity of the RHIC primary data, a very large number of computer-simulated events

requiring computing resources of comparable or even greater power are needed. The RHIC Physics Simulation initiative (RPS) will provide this needed simulation capability for the RHIC program.

The RPS proposal is responsive to the DOE's new focus on computational science, and is critical for providing simulation support for the RHIC scientific program. The RPS initiative is distinct from, yet complementary to, the physical construction of RHIC, its detectors, and the RHIC Computing Facility (RCF) which will acquire, organize and archive primary data from the RHIC detectors. The RPS will enable extensive simulation of theoretical models of RHIC collisions for comparison to the experimental results. It will benefit from and may merge into the Brookhaven initiative on Data Intensive Computing.

We also envision comparable scientific benefits of the RPS for the US role in the Large Hadron Collider program of high energy physics, especially as it relates to the physics needs of the ATLAS Detector program, in which BNL is a principal partner.

The RPS initiative includes a new 10 teraflop (TF) computing facility capable of supporting the extensive computing load required by detailed simulations of RHIC physics. The computing facility will be closely modeled on the existing 1 TF computing facility located partly at Columbia University and partly at BNL. That facility is operating at its planned rate and represents a breakthrough in cost performance and speed of construction. The new 10 TF machine that constitutes the heart of the RPS will be located at BNL. It will require about 2000 square feet of space and normal computing facility support functions (air conditioning, fire protection, etc.). The factor of 10 in computing performance will be realized in unit processor speed and in multiplicity of processor units. The per/node memory capability will be raised from 2 Mbytes to 64 or 128 Mbytes to match more closely the optimum configuration for event simulation. No significant changes will be made in the system's high-level architecture. All computing processor and memory chip sets are commercially available.

The expertise necessary to design, build, and commission the 10 TF facility is largely available at BNL. Expert advice on the practical implementation of a 10 TF machine is available from the Columbia builders of the existing 1 TF machine. The RPS initiative includes funding for the professional staff needed to create an operating system that will make the 10 TF practically accessible to RHIC and LHC users. Funding in FY 1999 will permit preliminary planning plus the initial recruitment of project staff.

4.2.4 RHIC Science Center (Exploring Energy and Matter)

Experiments at RHIC will be carried out using several collider detectors which are designed, built and operated by international collaborations of scientific groups. The four RHIC detectors now under construction have nearly 1000 collaborators from some 90 universities and laboratories representing about 20 countries.

Once RHIC is operational, it is expected that approximately 300 visiting scientists will be on site at a given time, to coordinate the experiments, operate the detectors, and analyze data while working alongside a Brookhaven staff of about 150 scientists and support personnel dedicated to this research. During short periods (e.g. workshops,

collaboration, meetings, etc.) an additional 100-200 visitors will be present at Brookhaven.

Although the AGS program is decreasing in scope, there is presently not enough space at BNL to accommodate such large numbers of visiting users for the RHIC facility. Moreover, since Brookhaven will be the focal point of a world-wide effort to carry out and analyze these experiments, the success of the activity requires space at BNL where large groups can work together, meet, exchange ideas, and be in close proximity to the experimental equipment, the computing facility essential for analysis of data, and the BNL research staff. There is no facility at Brookhaven that can provide this kind of consolidation of the RHIC research activity.

The RHIC Science Center will satisfy these needs by providing, in a central location, office space, meeting rooms, a conference hall, public computer terminals to accommodate visiting scientific staff, an equipment area to house the RHIC Computing Facility, and a lobby suitable for public displays and visitor orientation.

Construction of the RHIC Science Center will result in a program that can reach its full potential for research excellence and achieve the mission of a unique world-class research machine. The absence of a proper facility will require RHIC science staff to be dispersed throughout the BNL campus in temporary and ad-hoc facilities. We are pursuing avenues of shared financing by federal and state agencies.

4.2.5 Booster Applications Facility (Extraordinary Tools)

The construction and operation of the Booster Applications Facility represents DOE's close government partnership to provide extraordinary facilities and capabilities for research on issues of national concern. This initiative is consistent with BNL's critical outcome to provide innovative science, and our strategic objective to apply our unique research facilities to issues of human health.

On October 29, 1997 an Implementing Arrangement was signed establishing a formal collaboration between the Office of Life and Microgravity Sciences and Applications, NASA, and the Office of Energy Research, the Department of Energy (DOE). This agreement follows a formal Memorandum of Agreement (MOA) for scientific collaboration between NASA, and BNL. The major goals of the collaboration are (1) to use BNL's unique accelerator facilities, such as the Alternating Gradient Synchrotron (AGS) and the Booster to simulate aspects of the space radiation environment, (2) to support investigations of the response of living systems to radiation exposure in space and, (3) to promote science and technology developments that meet NASA requirements for radiation protection in space. These goals conform to the Memorandum of Understanding, signed on July 9, 1992, by NASA Administrator and Secretary of Energy, stipulating that "…DOE shall conduct research and maintain and operate irradiation facilities, including particle accelerators, necessary to simulate space radiation fields."

The space radiation environment consists of protons and electrons trapped in the Earth's magnetic field, protons (and some heavier particles) emitted during solar disturbances (solar energetic particle events), and Galactic Cosmic Rays (GCR), that are protons and energetic nuclei of other elements (HZE particles). Radiation effects due to

the heavy ion component of the GCR spectrum are of particular concern. The relative biological effectiveness or the quality factors of energetic heavy ions are not known.

Research on the radiobiological effects of high-energy heavy ions was carried out initially at the Lawrence Berkeley National Laboratory Bevalac which closed in 1993. BNL's AGS is the sole source of heavy ion beams in the United States that spans the cosmic ray spectrum. It delivers protons up to 30 GeV and heavy ions with energies up to 11 GeV/A. Since FY 1996, the AGS has delivered ^{56}Fe beams with energies of 600 MeV/A and 1 GeV/A. This is a benchmark comparison with work done at the Bevalac. Approximately 50% of the GCR dose is delivered by radiation with energies above 1 GeV/A.

In 1993, NASA commissioned a design study for a Booster Applications Facility (BAF) at BNL. That facility will deliver a complete range of high-Z, high-energy heavy ion beams with energies from 40 MeV/A to 1500 MeV/A, depending on the particular ion species. Separate NASA and DOE panels reviewed the design study, and a joint NASA-DOE technical panel subsequently reviewed a 1997 Conceptual Design Proposal and Cost Review Panel; all found the proposal technically feasible and the cost realistic. Some funding was received in FY 1998 to expedite the future construction with minimal interference to Booster and Relativistic Heavy Ion Collider operation.

4.2.6 Energy Resources (Fueling the Future)

The Laboratory has developed three focussed initiatives centered on BNL's expertise and unique facilities to advance toward clean, efficient energy resources.

Fuel Cell Catalysts: Structure and Activity: Fuel cells offer potentially large increases in efficiency for the production of electric power for transportation and for stationary generators. However, to make fuel cells effective the electrode catalysts must be improved. Low cost catalysts that are more tolerant to impurities in the fuel stream are needed. In the past several years, BNL has done several studies on the structure and activity correlation in electrocatalysis including work on metal single crystals as well as on dispersed carbon supported platinum and platinum alloy electrocatalysts. In addition, BNL has ongoing theoretical studies of alloys. This initiative will coordinate and expand these efforts, bridging the gap between the more fundamental studies and studies on real fuel cell catalysts, which are dispersed nanocrystalline materials.

BNL will use its unique abilities and facilities for this work, including X-ray scattering techniques developed to study in-situ surface processes; in-situ Fourier Transform Infra-Red (FTIR) spectroscopy and scanning tunneling microscopy (STM) and in-situ X-ray absorption spectroscopy (XAS). These techniques are a powerful combination for in-situ studies of surfaces and surface reactions in electrocatalytic systems.

The integrated program will address major aspects of electrocatalysis, emphasizing reactions such as oxygen reduction, hydrogen oxidation in the presence of carbon monoxide, and direct methanol oxidation. New catalytic systems based on monolayers, multilayers, and nanoparticles of bimetallic and alloy systems will be explored.

This initiative involves a collaboration with SUNY Stony Brook's Department of Materials Science and Engineering and with the Center for Advanced Thin Film Technology at SUNY-Albany, and is responsive to a New York State initiative in this area.

Nuclear Energy: The DOE is embarking upon a new Comprehensive National Energy Strategy. Nuclear energy research and development will play a major part within this strategy especially because of its key role in helping to reduce U.S. greenhouse gas emissions.

DOE's new approach to nuclear energy R&D, developed by the Office of Nuclear Energy, Science and Technology (NE), has two elements that are aligned with BNL expertise. The first, the Nuclear Energy Research Initiative (NERI), will revitalize nuclear energy research at major universities and DOE laboratories. For the NERI initiative, BNL will pursue a novel non-proliferation concept that employs Th and U-235 fuel in a light water reactor (LWR) to eliminate the potential for producing Pu. International collaboration is underway to complete the neutronic design for a Soviet-design VVER reactor, but design calculations are needed for other LWR types.

The second element is Nuclear Energy Plant Optimization (NEPO), which is being developed by DOE and the Electric Power Research Institute. The intent is to pursue technologies that foster life extension and generation optimization of existing power plants. Such efforts could greatly reduce global carbon emissions by enabling current Light Water Reactors to continue to operate beyond their license period. For the NEPO initiative, BNL will work in Aging Management and High Burn-up Fuel. BNL has NRC programs in plant aging, failure analysis, environmental qualification, and component testing, all key factors in determining plant life-extension. BNL also has NRC programs to delineate safety concerns for high burn-up fuel and assess methods for neutronic/thermal-hydraulic analysis of such fuel. These efforts can be directed to support to the industry's proposed "Robust Fuels Program."

New York State Energy Consortium: BNL is uniquely positioned to become a research and development support institution for utility companies located in New York State. BNL's ongoing research programs in nuclear energy, energy efficiency, material and chemical sciences, instrumentation and controls, biochemical processes, and environmental technologies have strong relevance to the production and distribution of electrical power.

BNL will expand its existing relationships with New York State utility companies so that BNL's unique capabilities will have significant impact in meeting the R&D needs of this industry. BNL will take advantage of existing industry organizations, such as the Empire State Electric Energy Research Corp. (ESEERCO) and the New York State Electric Research and Development Authority (NYSERDA), to formulate a strategic plan for working with the New York State utility companies. BNL will not only seek to utilize its own capabilities in supporting the utility industry's research objectives, but will also provide access to the capabilities of the other DOE national laboratories.

4.2.7 Environmental Quality (Protecting the Living Planet)

There is no single, simple solution to greenhouse gas warming nor to degradation of air and water. The key is to find the right combination of technologies and policies that can be implemented locally, regionally, nationally and globally, without severely impacting economic growth and quality of life.

Integrated Energy - Economic-Environmental Assessment and Policy Support: Brookhaven National Laboratory, a leader for over two decades in energy assessment and model development, is proposing an initiative to support two areas of current emphasis by U.S. and foreign policy-makers: global climate change, comprehensive energy and environmental assessments. This initiative builds on work developed at BNL, combined with private sector contributions, to create a public-private partnership that can address a wide range of analytical options and technical solutions to the issues defined by the public debate on global climate change, carbon management and international environmental security planning.

The primary tool employed under this initiative is MARKAL-MACRO, developed at BNL in the early 1970s. The model is a technology specific, data rich optimization model that will provide least cost energy system solutions under specified constraints to support policy and planning decisions. MARKAL-MACRO can be used to answer specific questions in conjunction with other models, such as air quality dispersion models, and Geographic Information Systems (GIS) representations. Some areas that could be examined are projections of greenhouse gas emissions under CO_2 constraints, evaluation of emission reduction options, ranking of technology portfolio options, or specification of the environmental impacts of alternative energy futures for a country or locality.

The current primary sponsors of this work are the DOE Offices of Policy and International Affairs and Nuclear Energy and the EPA Offices of Policy, Planning and Evaluation, Air Quality, and International Activities, and EPA Region 2. The work supports the United States participation in the Framework Convention on Climate Change, the role of nuclear energy in CO_2 reduction, conservation programs in Taiwan, and the use of MARKAL-MACRO in energy and environmental planning. Its applications are expected to increase when the BNL private sector partnership is implemented in FY 1998.

BNL-SUNY Stony Brook Joint Institute for the Study of Environmental and Public Health: BNL intends to establish a BNL-SUNY Stony Brook Joint Institute for the Study of Environmental and Public Health. A key feature of this institute is to provide a means to pursue areas of research in environmental sciences and environmental health issues of interest to DOE by providing a mechanism whereby emerging scientists can pursue research topics at BNL towards fulfilling the Ph.D. or postdoctoral requirements of their appointments at SUNY Stony Brook. The utilization of a university/laboratory collaboration in this manner will produce rigorously schooled scientists in the environmental and health fields with the experience and training to pursue topics of research interest to DOE, the New York region, and the nation. Three examples illustrate the rich portfolio of opportunities for collaborative research and training.

- Anthropogenic aerosols have recently assumed major importance for both global climate change and ambient air quality standards. The Intergovernmental Panel on Climate Change has identified aerosols as the largest source of uncertainty in the interaction of solar radiation with the atmosphere. In addition, EPA has suggested the promulgation of a new standard for atmospheric particulates below 2.5 microns in diameter, because of perceived health effects that these particles might be causing. This is a major issue, which could cause an enormous perturbation to American industry. A particular subject to be studied is the determination of the chemical composition of ambient particulates in the nanometer size range. Scientists from the environmental and medical departments at both BNL and SUNY Stony Brook will collaborate in joint studies.

- As a "Superfund Site," Brookhaven offers a real situation for studying environmental issues. Here we can both study and model the transport, transformation, and fate of organics, radionuclides, and heavy metals. At BNL, we have extensive experimental and analytical capabilities for monitoring soils and groundwater and for performing quantitative chemical analyses at very low concentrations. Students and faculty will be involved in well-designed research programs that, while affording opportunities for theses and publications, also provide directions to the remediation effort. Similarly, at the remediation end of the scale, BNL has technologies and capabilities that can employ students in the actual cleanup and post-cleanup monitoring programs.

- A broad area of opportunity is the study of the environmental effects of humans on the New York region. Because of its unique role in the U.S., New York constitutes a major urban laboratory for the environment. It is defined geographically as the drainage area of the New York Bight. From farmland to city park, and from canals and estuaries to open ocean, this region has almost 30,000,000 inhabitants. Studying how these inhabitants interact with the environment requires a major interdisciplinary effort. Sediment decontamination, groundwater, waste management, regional air pollution, along with many other problems await the study which an expanded collaboration between BNL and Stony Brook could provide.

The core capabilities and facilities to found this Institute already exist at SUNY Stony Brook and BNL. We will seek State, Federal, and private sector funds for faculty, students, and researchers appointed to the Institute.

Breast Cancer Research at BNL: This initiative is designed to develop better tools for diagnosing and treating breast cancer by taking advantage of the unique scientific expertise and facilities at BNL. Funding will be requested from DOE and NIH and we will respond to collaborative opportunities afforded by DOD and the private sector.

Diagnosis: Two different approaches to diagnosis are being evaluated; high contrast mammography using the NSLS, and development of radioisotope labeled compounds for enhancing sensitivity for early detection of breast cancer.

Early diagnosis of breast cancer is associated with a longer survival and a higher likelihood of complete cure. Current mammography screening techniques lack sufficient sensitivity and specificity to detect small tumors. Many mammograms, which are initially read as positive, turn out to be negative after biopsy. Research mammography

methods using NSLS should have a contrast at least 10 fold better than present mammograms, enhancing the sensitivity for early detection.

A parallel approach will use positron emission tomography (PET) as an imaging modality detecting malignancies on the basis of their biochemical characteristics. Also, it should help determine a tumor's stage and provide information on its characteristics which are currently available only by tissue biopsy.

Malignant cells grow out of control because the normal biochemical processes that regulate growth are disrupted. PET is used to measure sugar metabolism with a tracer called FDG, and is now used for visualizing sugar metabolism by tumors, locating metastases, and monitoring response to therapy. In addition, many breast tumors depend on estrogen, and the metabolites of estrogens may well change the control of DNA transcription, leading to uncontrolled cell growth. Estrogen metabolites are broken down by an enzyme called catachol-o-methyltransferase, or COMT, which is elevated in malignant breast tumors and, in some tumors, is under genetic control. An inhibitor labeled with ^{18}F that binds to COMT was recently developed at BNL. PET studies can reveal the distribution of COMT in breast tissues. Our studies will focus on validating this approach so as to understand the role of COMT and estrogen metabolism in cancer breast, on diagnosing breast cancer at an early stage, and on designing treatments and monitoring therapy.

Treatment: Research centers on developing radioisotopes to treat bone metastases and exploring the use of the Brookhaven Medical Research Reactor for the treatment of breast metastases to the brain using boron neutron capture therapy (BNCT).

Though the first line of treatment for breast cancer is surgical removal, half of the patients develop metastases whose control requires either chemo- or radio-therapy. Our research will investigate the use of radioisotopes such as (Sn-117nDTPA) for the palliation and treatment of bone metastases that are frequent in patients with advanced breast cancer. In addition, we will explore the use of isotopes produced at the BLIP, coupled to monoclonal antibodies that are directed against antigens abundantly expressed in breast cancer cells. Electron emitters offer the great advantage of using similar isotopes for imaging gamma rays at low doses and using the electrons for high dose therapy. In addition, immuno-conjugates may be labeled with certain positron emitters recently developed at BNL; their use could allow the early detection of breast cancer using high resolution PET imaging. The cytotoxic potential of radiolabeled antibodies could be enhanced through molecular engineering. We are working on fusing viral proteins to antibodies to increase the uptake of the labeled conjugate into tumor cells that could be used to image and/or destroy the tumor.

Brain metastases are not as frequent as bone metastases but they produce tremendous morbidity and compounds which we are currently using for BNCT of primary brain tumors, glioblastoma, are not suitable for metastatic breast cancer cells. However, several new compounds which show great promise for accumulating in breast cancer cells could be used as the basis of BNCT for brain metastases; we will pursue funding from DOE and other sources to test the feasibility of this approach.

4.2.8 National Security

As a key mission, DOE provides technical leadership for national and global nonproliferation and nuclear safety activities.

BNL's experience in developing nuclear, chemical, and biological detection, in measurement technology (laser spectroscopic systems, neutron and gamma measurements); exercises with the New York City Office of Emergency Management (NYC-OEM), and in international nonproliferation activities (Russian fissile materials safeguards; Chemical Weapons Convention negotiations, inspections and readiness; International inspections of U.S. nuclear facilities) collectively provide the basis for broad-ranging support of national and global security issues. BNL will develop, coordinate, and participate in multi-laboratory programs to help prevent proliferation of nuclear, radiological, chemical and biological weapons, such as placing effective, advanced, integrated controls on critical materials in the FSU and in other vulnerable states. We will focus our biotechnology expertise to improve emergency response and mitigation, and continue interactions with NYC-OEM. BNL will develop technologies and tools to help protect and ensure the integrity of U.S. critical infrastructures against terrorist attack. Three focus areas are proposed for FY 1999.

A Center for International Security: A Center will be established to work in the interface between technology and policy in international security. This research will be funded by private foundations and will complement the existing technical work in security currently funded by the Department of Energy.

The Center's mission will be to encourage another generation of technically trained people to enter this exciting field, to enhance the understanding and teaching of this subject in academia, and to enrich our staff and programs.

Programs at the Center will include summer institutes for students, a visiting intern program for academics, a senior visitor's program for experts in the field to interact with our staff, and workshops on current topics, with nationally recognized lecturers, resulting in a series of written proceedings.

Critical Infrastructures: DOE is part of an Inter-agency Task Force that deals with the vulnerability of critical national infrastructures, including our energy supply, transportation, emergency response, financial and information infrastructures. We focused our initiatives on transportation and related infrastructure technology.

Over the last decade, federal and local governments identified the growing crisis in the nation's transportation and infrastructure systems. The nation's intermodal transportation systems, rail, air and marine, are overused and under maintained. The associated infrastructure, including bridges, tunnels and utilities, is reaching the end of its design life expectancy. It is in the national interest to aggressively explore new technological solutions to these old problems.

BNL's staff can play a meaningful role in addressing these issues. We have initiatives in these areas, and have active research and development activities funded through Federal and New York State agencies, as well as private sector sources.

With the current success of these programs, plans are underway to expand our activities. BNL, Polytechnic University, and SUNY-Stony Brook have proposed to New York State a Center for Advanced Technology (CAT) in Advanced Polymer Technology

Applications to Infrastructure. This CAT will use BNL's experience in polymers and polymer concrete, and several Laboratory experimental facilities. Discussions are underway with the U.S. Coast Guard and the private marine sector to support research into human performance and ship safety. Lastly, our past automobile traffic modeling effort will be revisited to evaluate a new role for BNL in collaboration with PNNL and Battelle to support the U.S. Intelligent Transportation Program.

Total Terminal Security: Recent terrorist events, such as the bombing of the Federal Building in Oklahoma City and attacks against transit operations in Tokyo, Paris, and Baku, have re-focused attention on the vulnerability of transportation facilities. Prudent steps to develop cost-effective measures to minimize the number and severity of such incidents will include incorporating new systems for detecting weapons and explosives with other developments in physical security. With our background and experience in international safeguards, threat reduction procedures, and non-proliferation we will move in a direction to help assist the U.S. Department of Transportation (DOT) and others in achieving airport security.

Table 1 - Comparison of BNL Initiatives with DOE Themes

Brookhaven National Laboratory New Initiatives	
Themes	**BNL Initiative**
Exploring Matter And Energy	**Proteome Project** Physics Simulation Facility
Extraordinary Tools for Extraordinary Science	**BNL Center for Data Intensive Computing** **Deep Ultraviolet Free Electron Laser** NSLS Phase III Upgrades Booster Application Facility RHIC Science Center Protein Crystallography
Protecting Our Living Planet	**Environmental Carbon Observatory** Breast Cancer Research Energy-Economic-Environment Assessment Policy Support Joint Institute for the Study of Environment and Public Health Center for International Security Critical Infrastructure
Fueling the Future	Fuel Cell Development Nuclear Power Optimization NY State Energy Consortium

The following table provides the resource projections for the Laboratory and Programmatic Initiatives. The Laboratory Initiatives respond to DOE's science and technology mission, are the focus of senior Laboratory Directors and senior Management, and will receive initial support from our Laboratory Directed Research and Development funds. Programmatic Initiatives extend our research and technology base. They build on developments at BNL, new opportunities provided by the DOE, other federal agencies, New York State, and industry.

Table 2 – Resource Projections for Laboratory and Program Initiatives

Brookhaven National Laboratory Initiatives FY 99 to FY 03
Total Estimated Costs in FY 1998 Dollars (Millions)

	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
NSLS DUVFEL Facility			$3.3	$6.1	$6.1	$2.7
BNL Center for Data-Intensive Computing		$1.0	$4.5	$5.0	$5.0	$5.0
Environmental Carbon Observatory (a)	0	$0.5	$5.0	$11.0	$20.0	$33.0
Proteome			(b)			

Brookhaven National Laboratory – Program Initiatives FY 99 to FY 03
Total Estimated Costs in FY 1998 Dollars (Millions)

	FY 1998	**FY 1999**	**FY 2000**	**FY 2001**	**FY 2002**	**FY 2003**
NSLS Phase III Upgrades			$8.5	$18.5	$6.7	
Protein Crystallography at NSLS		(b)				
RHIC Physics Simulation Facility		$0.5	$6.0	$6.0		
RHIC Science Center			$1.6	$10.0	$8.2	
Breast Cancer Research (c)		$.3	$.3	$.3		
Energy Research		$2.0	$2.1	$2.2	$2.2	$2.2
Integrated Economic Environmental Assessment and Policy		$2.0	$2.0	$2.0	$2.0	
BNL SUNY Institute For Environment and Public Health		$2.0	$2.5	$3.0	$3.0	$3.0
National Security Collaboration	$0.1	$3.5	$5.0	$6.0	$4.0	$4.0
Critical Infrastructure		$1.0	$2.0	$2.0	$2.5	$2.5
Booster Applications Facility		$11.0	$11.3	$3.0	$4.5	

(a) This is the request from DOE. Other partners will be sought.
(b) Costs for the Proteome Initiatives are under development.
(c) Resource needs are under discussion between NIH and DOE-OBER.
(c) BNL will seek additional funding from the Breast Cancer Initiative at SUNY Stony Brook

5. Operations and Infrastructure

The goal of Laboratory Operations, Infrastructure, and Technical Support organizations is to provide timely and quality support services enabling BNL's scientific missions to be fully realized safely and efficiently. Support operations also play a critical role in achieving the User Facilities' Critical Outcomes: maintaining a world leadership position and the highest standard of satisfaction among users.

During a 55-day transition to new management under Brookhaven Science Associates (BSA), all aspects of BNL operations were assessed. While those activities clearly provide only a snapshot of conditions at the Laboratory, the transition provided incoming managers with a fresh look at conditions, and a starting point for evaluating and determining further needed improvements. Key to improving every operation at the Laboratory will be the clear definition of roles, responsibilities, authorities, and accountabilities. In the immediate future, BNL will develop and implement a Management Plan and move to Performance-Based Management.

Management Plan: Ownership by individuals at all levels of the organization, especially in line management, is essential to BSA's management plan. Efforts in every area will establish and reinforce this concept. Laboratory-wide Critical Outcomes will flow down to Performance Objectives and further to Performance Indicators and Measures for organizations and for individuals. Performance Objectives and Measures will be developed in partnership with DOE before their inclusion in the FY 99 Appraisal Plan and operating contract. For individuals, the Measures will be major factors in establishing clearly defined and agreed-upon Roles, Responsibilities, Authorities, and Accountabilities for each employee. This will ensure that employees comprehend all aspects of their position, and its importance in the functions of the Laboratory, and are fully empowered to succeed. This will further reinforce both our performance expectations for the individual and the commitment of their immediate supervisor to provide the necessary latitude and support to accomplish those expectations.

At the organizational level, ownership will be further demonstrated by Facility Use Agreements and the concept of "Fee-for-Service." Facility Use Agreements will be executed between the Deputy Director for Operations and the facility owners. The requirements will flow down to users by the execution of specific agreements between owner and user. The Agreements set the conditions that must be met by each party to assure safety and compliance with requirements. Fee-for-service further allows facility owners to exercise ownership by choosing for their organization the type, quantity, and timing of support services. Owners will determine, through rigorous self-assessment, the services necessary for smooth, efficient, safe, and compliant operations. The support services offered range from consultation on waste generator issues, to work site safety evaluations, to office space, power, engineering support, and even include technical assistance on the self-assessment program or in determining corrective actions.

Performance-Based Management: The Management System Improvement Project (MSIP) was initiated in June 1997 to address needs highlighted by the April 1997 Office of Environment, Safety and Health (EH) Facility Review. The project has three areas of focus: Leadership, Communications, and Integrated Safety Management. Assessments during Transition highlighted areas that need alignment with the Critical Outcomes. Work is underway to broaden the MSIP and refocus it on the Critical

Outcomes, Objectives and Measures, and the activities that will support their accomplishment. Other changes include the adoption of a Standards-Based Management System in use at Pacific Northwest National Laboratory PNNL, which provides policies, expectations, procedures and guidelines governing all work.

Four of the Critical Outcomes relate to support and infrastructure functions. The support organizations are critical to the scientific departments' achievement of Critical Outcomes in science and technology, other DOE strategic missions, and excellence in user facilities. The support Critical Outcomes subject areas are:

- Operational Excellence
- Environment and Clean-up.
- Communication and Trust
- Leadership

Objectives will be developed to guide the Operations and Technical Support programs in achieving the outcomes.

Operational Excellence: BNL will manage and operate all Laboratory assets with distinction, fully integrated with the scientific and technology mission while being fully protective of worker, public and the environment.

Objectives

- Communicate the expectations for performance;
- Develop and implement roles, responsibilities, accountabilities and authorities for managers and workers;
- Incorporate expectations into individual performance evaluations;
- Provide line managers with the specific resources needed to meet their Environment Safety and Health (ES&H) and operational responsibilities while giving them with the maximum possible control over their costs;
- Develop and maintain an integrated, job relevant and cost effective training program;
- Provide effective, cost efficient information management systems for the scientific programs and the business functions.

Environment and Cleanup: BNL will be an exemplary steward through safe and aggressive clean-up, efficient waste management, and effective communication of the environmental health of the Laboratory.

Objectives:

- Implement environmental cleanup remedies in an cost-effective and efficient manner;
- Eliminate legacy wastes, and minimize generation of future wastes;
- Understand and communicate past, current and future environmental impacts;
- Ensure stabilization of legacy facilities to prevent potential impacts to our workers, our neighbors, and the environment.

Communication and Trust Involvement and Benefit: We will be recognized as a community asset, a good neighbor, and a valued employer.

Objectives:

- Enhance the effectiveness and responsiveness of Laboratory communications with stakeholders;
- Create opportunities for community involvement in decision making processes and achieve a better understanding between the Laboratory and stakeholders;
- Become a good neighbor and community asset;
- Develop appropriate communications management systems and infrastructure.

Leadership: BNL will be recognized by DOE, users, and staff as the national laboratory with the highest quality leaders and the most effective and efficient management.

Objectives:

- Create a pool of talented, diverse, empowered, and goal-oriented leaders/managers;
- Provide effective and efficient business management, including the required systems for financial, information, and human resources.
- Provide high quality work environment which permits BNL to attract and retain an excellent workforce.
- Develop and implement a Laboratory-wide self assessment program.

5.1 Environment, Safety, and Health (ES&H)

The Environment, Safety and Health Program (ES&H) at BNL supports the Laboratory's aspiration of being the Department of Energy's premier fundamental science laboratory. To accomplish this objective, excellence in environment, safety, and health protection within our operations must be achieved. BNL's new ES&H organization and management systems will provide the highest quality, most effective and efficient products and services to its internal and external customers in support of BNL's mission. In so doing, the Laboratory will meet the critical outcomes related to its science and technology mission.

Goals and Objectives: The scope of the Critical Outcome for "Operational Excellence" includes all aspects of ES&H and operational performance except environmental restoration and waste management. These are addressed separately. The Objectives and Measures provide the foundation for BNL to communicate expectations for ES&H and operational performance; develop ES&H and operations managers and workers roles, responsibilities, accountabilities and authorities; and incorporate ES&H and operations expectations into work plans and individual performance evaluations.

Philosophy and Approach: ES&H activities will become an integral part of all BNL's work. A set of integrated ES&H and operational management systems will be established to ensure that work is accomplished in a safe, environmentally sound manner by carefully applying controls tailored to the work being performed. ES&H activities will be integrated into the work during the planning phase, rather than attempting to impose requirements onto the work later. This will enhance line ownership of ES&H performance and result in more effective and efficient ES&H technical support services and shorter cycle times for scientific exploration and construction projects. Managers responsible for work are expected to understand the resultant hazards, establish appropriate control measures before work is started, and ensure appropriate control of all

workplace risks. Technical ES&H and operations support staff will assist managers in meeting these responsibilities as "purchased services." These will be paid directly from project or research funds controlled directly by the purchaser. The ES&H Services Division will give project managers and line organizations the maximum possible control over their costs, while, ensuring that operations are carried out in a safe, compliant, and environmentally sound manner.

5.1.1. ES&H Management Improvement Initiatives

One notable element of the ES&H Program is an Integrated Safety Management System (ISMS). Beginning in FY98, several initiatives were started to improve the ES&H and operations/infrastructure:

- Improvements to in-line Self-Assessment of ES&H and operational performance. Self-assessment of all aspects of work is a primary responsibility of line managers.
- Implementation of a Commitment and Corrective Action Tracking System (CCATS). This system will provide management with ready access to the status of commitments made by BNL to DOE, regulators, and other stakeholders.
- Improvements to the system for prioritizing ES&H and Infrastructure needs
- Improvements in work planning have been implemented in both scientific exploration and routine work. The intent is to ensure early and appropriate integration of ES&H and operational performance expectations into the work of the Laboratory.
- Reduction of the frequency and severity of work place injuries, and improved monitoring of the amounts and locations of hazardous chemicals in BNL workplaces.
- Examination of the existing set of ES&H and Conduct-of-Work Standards and Requirements to ensure that these are appropriate requirements, policies, and procedures for all hazards in the workplace.
- Review of existing ES&H and Operations Management Information Systems to address ES&H and operational requirements and control costs and risks in an effective, efficient manner.
- Review of the existing environmental management systems in conjunction with the DOE and EPA.
- Establishment of an Independent Oversight office reporting directly to the Assistant laboratory Director for ES&H and Quality to verify that the line Self Assessment programs meet expectations and to conduct independent assessments upon request.
- Development of an Environmental Compliance Representative Program to support the commitment to EPA for a rigorous examination of hazardous and radioactive waste streams during 1998 and 1999.

- Identification and correction of environmental vulnerabilities highlighted by the Facility Review Project.

Table 3 summarizes the current budget projections for ESH initiatives.

5.2 Environmental Management

The Critical Outcome for Environmental Management at BNL is derived from our commitment to the environment and cleanup of the Laboratory. "...BNL will become an exemplary environmental steward through safe and aggressive clean-up, efficient waste management, and effective communication of the environmental health of the Laboratory."

5.2.1 Environmental Remediation

Our goal is to proactively remediate contaminated areas. This will be accomplished safely, within established schedule and costs, and in a way that protects the public and the environment.

Objectives:

- Enhanced and integrated planning and application of innovative technologies and project management and control systems.
- A comprehensive self-assessment program to validate compliance with applicable laws and standards.

The goal of BNL's restoration program is to complete remedial activities by the year 2006 (DOE Environmental Management 2006 Plan). This includes soil and groundwater remediation and decontamination and decommissioning of the Brookhaven Graphite Research Reactor (BGRR).

Soil and sediment contamination, primarily at the old Hazardous Waste Management Facility and in the Peconic River bed, will be remediated by the year 2001. The Laboratory will continue to rigorously investigate the groundwater, performing comprehensive modeling and eliminating environmental vulnerabilities (e.g. cesspools). Public water has been provided to homes south and east of the site to assure the quality of the community's drinking water, and several groundwater remediation systems are operating.

BNL will draw on the experience from Argonne National Laboratory's decontamination and decommissioning at CP-5, as well as the plans and experience at Hanford's 105-C reactor. The groundwater problems associated with the BGRR will be included in BNL's overall focus on on-site groundwater contamination.

Table 3 shows the projected costs for the environmental restoration program.

5.2.2 Waste Management

The following strategies will provide a waste management program of continued prudent planning, safe work practices, and substantial accomplishments:

- Provide stewardship of waste by assisting generators with cost-effective support for disposal;
- Assign ownership for waste legacy and drive its disposition in a focused, project-oriented manner;
- Aggressively pursue waste avoidance and minimization;
- Create a Laboratory framework for ownership of all waste and ensure that no waste is created without adequate identified funding and a pathway for its disposition.

BNL implements a comprehensive Pollution Prevention (P2) program to reduce the quantity and toxicity of wastes generated on-site. The program is structured to evaluate and reduce waste generation at the source. All waste types are targeted for reduction, including radioactive-, mixed-, hazardous-, and solid-wastes. Processes and waste streams are assessed to identify opportunities for pollution prevention based on several priorities, including environmental risk, health risk, cost, and possibility of success. Opportunities identified then are pursued for funding and implementation.

Objectives

- Foster a laboratory-wide philosophy to conserve resources, reduce the costs of waste disposal, minimize waste generation and pollution.
- Promote the use of non-hazardous materials at BNL to minimize the potential risks to human health and the environment.
- Reduce or eliminate the generation of waste materials by using substitutes, reformulating products, modifying processes or laboratories, improving housekeeping, and initiating on-site closed-loop recycling.
- Comply with federal and state regulations and DOE requirements for waste minimization and reduction and pollution prevention.

BNL's P2 Program supports the implementation of systems to provide accurate and current waste stream-specific information.

Specific opportunities for pollution prevention have lead to the steady decline in the quantities of hazardous, mixed, and radioactive wastes generated from routine Laboratory activities. Measured from the DOE-established baseline year of 1993, BNL has reduced routine hazardous waste by 54%, routine mixed waste by 67%, and routine radioactive waste by 10%.

These successes were due to the investment made by the DOE and BNL in implementing pollution prevention opportunities. The Return-on-Investment program, established at the DOE-HQ level (EM-77), provided approximately $500k annually (since FY96) to fund such implementation at BNL. Out-year budget projections from EM-77 indicate that the funding level will decrease beginning in FY99; DOE then

expects a transition to funding from the programs that are responsible for generating waste.

During this planning period, the Laboratory will finalize the legacy waste project, completely removing the waste from the site by FY2000 and continue to pursue opportunities for pollution prevention and waste minimization. The projected resources for Waste Management Activities are given in Table 3.

5.2.3 Environmental Monitoring and Integration (OEMI)

The Laboratory will develop an integrated multi-media environmental monitoring program that will enhance the coordination, efficiency, and effectiveness of the Environmental Restoration and Waste Management Divisions. It will improve responsiveness to stakeholders' concerns, and increase community awareness of the Laboratory's overall Environmental Management mission through the regular issuance of information focused on the environment.

Each of the monitoring programs will be evaluated to determine where efficiencies can be secured by combining or eliminating activities. Benchmarking of successful programs at other DOE sites will be done so that their successes can be rapidly applied to BNL. In house capabilities will be developed and close working relationships established between environmental management and scientific research entities to sustain the anticipated improvements in the Environmental Monitoring Program. Key elements of the Environmental Monitoring and Integration Strategic Plan are the following:

- Enhance responsiveness to the community for information/data by providing access to data and information quickly and completely.
- Enhance Laboratory management decision support and responsiveness. A Personal Computer (PC) based environmental database is envisioned to allow convenient, but secure, access to environmental information.
- Establish the status of the environmental health of the site. We will consolidate all environmental data into one accessible database.

5.3 Community Involvement and Public Affairs

The Laboratory will re-establish confidence and build trust to change the cultural environment in which BNL operates, and to establish a philosophy of public involvement which acknowledges the concerns of its stakeholders and seeks their input on issues, facilities, and operations they deem important. We will seek to engage and involve employees in a shared sense of responsibility and accomplishment and to extend this shared sense of accomplishment to its external communities. BNL will continue to build upon its communications and community relation's successes and expand its base of support.

Establish Credibility and Trust with the Community: The Laboratory will enhance the responsiveness and effectiveness of communications with internal and external stakeholders. Laboratory managers and employees who are expected to interact with the public will be trained in risk communication and managers who are expected to serve as spokespersons will be given media training. BNL will establish a stakeholder

involvement criterion as part of the performance appraisal for managers and project decision-makers, and as an incentive for employees who volunteer for community involvement. We will create a coordinated and up-to-date internal communication program including on-site communication media (Brookhaven Bulletin, Glance, WBNL, and the intranet).

The Laboratory will create opportunities for community involvement in the decision making processes. BNL will establish a Community Advisory Group to provide advice and counsel, and create issue-oriented task groups to deal with issues of community concern. BNL will continue to develop multiple opportunities for community interaction. Planned activities include Meet the Scientist Forums to encourage dialogue among the scientific and technological community, educational community, employees, and neighbors.

***Achieve a better understanding between the Laboratory and internal and external stakeholders*:** BNL will survey internal and external stakeholders to obtain a better understanding of their attitudes. These surveys, which will be updated biannually, will provide a basis upon which to develop communications initiatives and involvement programs with BNL's stakeholders and evaluate their effectiveness over time.

The Laboratory will establish an envoy program as a structure that will enhance the ability of employees to listen and give feedback to key community groups, and will expand the speakers' bureau to afford opportunities for BNL employees to speak at community events about their research or areas of expertise.

Enhancement of the ambassador program will allow BNL's employees to participate in short-term community volunteer activities, such as the Habitat for Humanity, roadside cleanups, and telethon drives.

BNL will broaden outreach efforts to include stakeholders in Nassau County, western Suffolk County and the east end of Long Island. We will develop our Web Page to give the public with access to questions and answers on issues of importance.

BNL will continue and expand education programs. To broaden the quality of and audience for, educational programs, BNL will seek opportunities to form partnerships with the University at Stony Brook, New York Institute of Technology, Hofstra University and other Long Island institutions of higher education. The Laboratory will use the School District Technical Assistance Program as a model to help establish a Long Island Technical Assistance Organization linking existing efforts of organizations, such as BNL, USB, Cold Spring Harbor, BOCES, in a coordinated technical assistance program for Long Island school districts. We will develop programs for senior citizens and community "meetings" or "gatherings" on topics such as Radiation, Health Research, Positron Emission Tomography (PET), and we plan to revitalize the Scientist in Residence program.

5.4 Human Resources

The Human Resources Program is instrumental in BNL's ability to achieve all of the Critical Outcomes. As stated by the Director in the Introduction, the success of the Laboratory depends on ". . . maintaining the highest standard of excellence in each of the

talents, skills and crafts needed to produce the whole…" BNL strives to achieve a diverse, integrated, and productive workforce.

The Laboratory pursues two interdependent human resource goals:

- A diverse, highly skilled, productive and efficient workforce. BNL seeks to employ a workforce that reflects the diversity of the labor pool from which qualified applicants are available, and enables the Laboratory to fulfill its mission at a cost that provides value to the nation.
- Equal Employment Opportunity and Affirmative Action. The Laboratory complies with all applicable laws and regulations in establishing and applying human resources policies and practices. Employees should be (1) informed about human resources policies and practices that affect them, and treated fairly and consistently, and (2) given opportunities for career and salary advancement, regardless of ethnicity or gender.

To accomplish these two goals, Human Resources employs the following strategies:

- Select and place job candidates in accordance with job requirements and affirmative-action goals. Hiring managers will be informed about the areas in which they can help to meet affirmative action goals, and they will be provided with qualified candidates to select from.
- Develop and maintain an integrated training program that will provide job-relevant, high-quality, and cost-effective training to Laboratory employees.

The Human Resources program is focussed on meeting several objectives under the Critical Outcome of Leadership. The Management Development Initiative of the MSIP will identify development needs and provide the tools to improve management skills. The program will include a hierarchy of training requirements for all management levels, a succession planning process, and an internship program for middle managers. The Management Evaluation and Reward Initiative will focus managers on reaching their goals.

The performance appraisal process and compensation program will be revised to identify performance levels to reward individuals who show outstanding performance. A Laboratory-wide Training organization will be formed by the end of FY 1999 and a new policy issued supporting Laboratory Critical Outcomes: completing the documentation of training requirements, based on assessments of job- and workplace-hazards; completing the development of the computerized training management system; implementing a personnel qualification system using training requirements data and the training management system. The Laboratory will conduct a value-added review of existing training requirements and courses, to validate requirements and ensure the appropriate return on BNL's current investment in training.

Finally, to identify areas where the Laboratory can enrich the work environment, an organizational survey will be conducted by the end of FY 1998. This will highlight the Laboratory's strengths and weaknesses, as viewed by employees. The Laboratory will respond to employees' recommendations and provide feedback on results of the survey.

The Laboratory will continue to strengthen the link between pay and performance, while maintaining overall compensation at competitive levels. New forms of compensation and rewards will be implemented that drive performance beyond expectations and help to achieve Laboratory objectives. These include an incentive program for top management focussed on Critical Outcomes and the achievement of individual goals linked to those outcomes.

5.5 Information Technology and Business Information Management

It is the Laboratory's goal to provide the most advanced computing tools and technologies, the best high performance communications infrastructure, and customer support essential for the operation of the Laboratory and critical to the advancement of research conducted at BNL. CCD will continue to provide the foundation for recentralization of scientific computing at BNL by providing a superior high-performance computing environment that is well supported.

Information Technology (IT) is a critical part of Brookhaven's future and therefore is the subject of intensive planning to ensure that the computing infrastructure can adequately support all scientific, engineering and business operations. A plan is being developed for a computing environment that is well-integrated, utilizing standards for enterprise-wide functionality with the benefit of economy-of-scale services, and cost savings. Operational issues relating to computer security and Year 2000 are managed by senior management with clear policies and procedures.

The Computing and Communications Division has primary responsibility for scientific and technical computing services at the Laboratory. CCD provides implementation, management and support of the BNL Computing Facility, desktop computing, the computer network and the telephone system. A basic computing environment for all BNL staff that provides immediate access to information over cutting-edge networks using current systems technology, will be funded by Laboratory overhead. This is referred to as "CORE" in a CORE-PLUS model. Extraordinary services, identified either by quantity or distinction by type are identified as "PLUS" and are directly charged to users, either internal or external. This methodology will allow BNL to move toward standardization with all of its benefits in functionality and cost, and the nationalization of the network.

Over the next year, both Physics and NSLS computing will be concentrated within the BNL Computing Facility. CCD will continue to provide intellectual, as well as physical plant and infrastructure support for the RHIC Computing Facility, RIKEN BNL QCD/SP facility, and the Data-Intensive Computing Initiative and will be crucial to the success of these projects.

The success of CORE-PLUS will be measured by the quality of service improvements and integration of the Lab-wide IT infrastructure over time. Bringing high level IT to the scientific programs and our customers in industry and universities would be possible through the development of trusted partnerships. IT strengths in scientific visualization, advanced networking, computer training, enterprise IT solutions, and computer supported collaborative work will be leveraged through these partnerships.

Business Information Management is vital to the effectiveness of the scientific programmatic performance, as well as the efficiency and cost-effectiveness of

administrative functions. It is the Laboratory's goal to provide the technical staff with state-of-the-art computational resources that meet the research program's needs. The Business Information Systems will have the necessary resources for development, programming, administrative architecture, security and applications architecture, application training and archiving for major business systems. The Information Services Division will achieve fully electronic management of scientific, technical, and other documentary information, from its initial generation to archival preservation.

The Financial Services Division (FSD) facilitates the implementation of several major new administrative information systems, starting with an integrated suite of financial management software packages purchased from PeopleSoft, Inc. By the beginning of FY 2000 all existing applications, except Human Resources and Payroll, will be moved from the existing Hewlett-Packard mini computers to a Windows NT operating system. In addition to implementing the multi-year PeopleSoft packages, FSD identified several other projects that will benefit the BNL community in the near term. These include the completion of the Brookhaven Training Management System, establishment of a centralized Guest/Visitor Registration & Tracking System, streamlining of labor entries, reduction of paper reports, and electronic (check-less) payments.

BNL is replacing the accounting system and all its feeders with an 'off the shelf' suite of integrated financial packages, and will modify the Laboratory's business practices to match the product's features. The mandate to implement an off-the-shelf centralized accounting system and modify BNL's business practices to match provides the impetus to re-examine the latter. The quality assurance process will ensure the availability of system and user documentation and the administration of user training. The PeopleSoft financial applications are Y2K compliant and their use will mitigate this problem for all the core financial systems. Of the legacy applications not being replaced by PeopleSoft, all are Y2K compliant except Travel and the Job Cost & Reporting System; both will be replaced before FY 2000.

BNL's goal of fully electronic information management will increase the efficiency with which the Laboratory's scientific, technical, and archival information is managed, and will maximize ease of access to information throughout its life cycle. The near-term strategies include initiating electronic transmittal of full-text documents, building and maintaining document- and image-repositories, providing electronic publishing, providing library and records management services, and making information accessible to users from their desktops on the WWW. Building on this foundation, the Laboratory will be positioned, in the long term, to leverage its information by using sophisticated search engines, electronic information management systems, and emerging technologies.

5.6 Assets Management

The Laboratory maintains comprehensive Assets Management Programs that encompasses all of the elements necessary to utilize, control and dispose of its assets in a cost effective and efficient manner. Asset management is divided into two general categories, real property and personal property.

Real Property: Real property records are maintained in the DOE Facility Information Management System (FIMS) and reconciled with the Laboratory's financial

records. As part of the Facility Inspection Program, FIMS records and building key plans are reviewed during field surveys to ensure the records are accurate. Building condition information, deficiency lists, and requested upgrades are reviewed to determine facility life-cycle plans and identify those assets for which further capital investment is warranted or for which demolition is the best plan. For assets the Laboratory seeks to demolish, either DOE ER landlord funds or DOE EM-40 funds (those assets meeting the criteria for facility transfer) are requested.

Personal Property*:* The Laboratory utilizes an active Walk-Through Program to ensures that every major facility is reviewed on a scheduled basis to insure that all appropriate equipment is identified and properly controlled as well as to monitor and identify any idle or surplus materials. In addition, the Laboratory also uses a site inspection program to monitors the accumulation of materials. These programs, coupled with the Waste Minimization Program provides the Laboratory with the ability to dispose of surplus assets in a timely, efficient manner, consistent with the appropriate Federal and Department of Energy Property Management Regulations.

5.7 Site and Facilities

The BNL site consists of approximately 5, 320 acres and about 30% of the total area is developed. There are approximately 350 buildings in use with a total area of 387,000 square meters (4.1 million square feet). Approximately 25% of the buildings date from World War II. Most of the remaining buildings were constructed in the 1960s (see Tables 4, 5, and 6). The site is served by site-wide electrical, steam, sanitary sewer, storm sewer, and potable water utility systems. There are limited distribution chilled water and compressed air systems.

BNL is located in the Long Island Pine Barrens Region, is the site of the headwaters of the Peconic River, and is situated over an Environmental Protection Agency designated sole source drinking water aquifer. The Laboratory is on the federal and state Superfund lists and is engaged in an aggressive environmental remediation program.

Buildings: Approximately 78% of BNL's building space is over 30 years old, with one-third of that over 50 years old (Figures 2 and 3). Maintenance, repair, and capital renewal costs are high and the buildings are small and dispersed across the site. Budget constraints are causing extended deferral of capital renewal and replacement projects, as well as annual maintenance. Maintenance and energy costs for the older, wood frame buildings are higher than those for structures that are considered permanent. In addition, retrofitting older facilities to comply with current ES&H standards is extremely costly. Consequently, our planning efforts are directed toward identifying those facilities for which further investment will yield economic life-extension, and those facilities where the best course of action is demolition.

Downsizing maintenance staff has resulted in residual capacity to perform only limited preventative and breakdown maintenance. Roofing systems are failing or have failed and require replacement. This condition is exacerbated by the simultaneous failure of second-generation roofs on many of the older facilities. A 1993 Multi-program Energy Laboratory Facility Support (MEL/FS) project replaced about 25%; however, additional failures have since occurred. In addition to the potential damage to equipment,

prolonged water infiltration will lead to structural damage and the shutdown of facilities for extensive repairs, or abandon and replace.

***Utilities*:** Site-wide utility systems have been a high priority for maintenance and capital renewal over the years and have received good support from the Multi-program Energy Research Facilities Support (MEL/FS) program. In addition to ensuring operational continuity, properly maintained and updated utility systems are key to safe and environmentally benign operations.

The Central Steam Plant is highly reliable as a result of the two fairly new boilers. However, upgrades are needed to an existing 30-year-old boiler and the building enclosure. Our recent conversion to dual fuel (fuel oil/natural gas) should ensure that the Laboratory complies with emerging environmental regulations. Underground distribution lines will require limited replacement in the future.

With the commissioning of RHIC, the Laboratory's peak electrical demand will grow by about 30%. Additional capacity to deliver power will be needed and is being accommodated through power factor corrections. Transformer capacity is adequate; however, future additions will be necessary to re-establish firm capacity. The primary 13.8KV distribution feeders are aging. Fourteen are over 40 years old.

BNL continues to enjoy favorable electric rates under a contract with the New York State Power Authority (NYPA). Electric deregulation has been slow to develop in New York and will be even slower on Long Island due to the resolution of the acquisition of the Long Island Lighting Company (LILCO) by the Long Island Power Authority (LIPA). BNL is currently evaluating strategies for electrical power sources after the NYPA contract expires in July 2000.

The outfall from the Sewage Treatment Plant discharges to the Peconic River, which has been designated as a New York State Wild and Scenic River. Recent upgrades to the plant provided tertiary treatment and ultraviolet disinfection. A water conservation program, combined with a campaign to eliminate cooling water discharges, decreased sewage volume so that permit conditions on biological oxygen demand removal are now routinely met. Sanitary sewer lines were surveyed and about 7,000 linear feet replaced, more require replacement.

Recent improvements to the Chilled Water Plant include a chilled water storage capability that generates chilled water during evening hours, periods of low electrical use. This provides about 20,000 ton hours of additional cooling capacity and reduces peak electrical demand on site by about 1 MW.

The potable water system was recently improved by installation of new mains, carbon filtration, air stripping of volatile organics, repairs to the water towers, and improvements to the Water Treatment Plant. No further upgrades are planned or needed now.

General Plant Projects (GPP) and General Purpose Equipment: The Laboratory historically relied on GPP for small, urgent project needs. BNL developed a process for assigning priorities to ES&H, Infrastructure and Program Support project needs and is testing the process for the FY 1999 program. Currently, the bulk of high priority needs lie with ES&H. While the size of the GPP project has been increased to $5 million, and opportunities exist to make significant improvements and save costs by replacing and consolidating buildings, it is unlikely that BNL can use this increased

flexibility due to the need to work down the backlog of these projects. In FY 98, a one time increment of $1 million in GPP funding was given for projects.

BNL's General Purpose Equipment (GPE) budget is approximately $4 million annually to support equipment needs for the operations of the Laboratory. To cover a significant shortfall, equipment expenditures were reduced by 50% in FY 98, deferring $2 million in capital equipment needs.

Multi-program Energy Laboratory/ Facility Support (MEL/FS) Program: BNL will continue to use the funds available through this program to upgrade environment, safety, and health (ES&H) protection, improve utility systems, increase the staff's efficiency through consolidation, and also to replace, mothball or demolish aged inefficient facilities so reducing operating costs. The MEL/FS projects are those in excess of $5 million and which require Congressional approval.

BNL will continue to evaluate condition assessment data for its permanent multi-program facilities, and will propose line-item projects to rectify deficiencies and bring the facilities up to current standards. Such projects include replacement space for the Departments of Advanced Technology and Applied Science, both of which will consolidate functions and eliminate sub-standard space.

Various assessments identified the need for new support facilities; these include a new Police Headquarters, Visitors Reception Center, Central Training Facility, and a community outreach area. These proposals have several common drivers including the poor condition of existing facilities and inefficiencies in current operations. Additionally, certain support functions must be consolidated to maximize efficiencies and reduce costs. With the commissioning of RHIC, facilities will be needed to accommodate approximately 250 scientific users. BNL developed strategies to address these concerns which include projects to combine functional requirements, and a Visitors Center and a RHIC User facility.

In establishing the projects proposed for this planning period, the Laboratory used the revised Environment, Safety and Health and Infrastructure priority process. This process helps the Laboratory balance ES&H and infrastructure needs in consistently ensuring longer term ES&H improvements to decrease future liabilities, and improving the overall infrastructure of the Laboratory to enhance the efficiency and efficacy of the research environment.

The projects proposed for FY 1999 through FY 2004 represent the application of strategies, which include compliance with regulations, workers' protection, proactive protection of the environment, preservation of assets, and reliability of utilities. In FY 1999, the Laboratory proposes the third and final phase of improvements to the Sanitary Sewer System and the start of a phased program to improve the electrical distribution system. The Sanitary system will be expanded to accommodate building at the RHIC complex as well as extensive replacement of lines which may be a potential source of contamination of the groundwater. The electrical system upgrades will increase the system's reliability by reducing the number of planned outages to the Laboratory's research facilities.

In FY 2000 we are proposing a significant Ground and Surface Water Protection project that will move the Laboratory to a more proactive position in protecting ground and surface water. We will eliminate cross connections between storm- and sanitary-

lines, reduce discharges of cooling water to the sanitary system, and undertake other modifications.

In FY 2000 we also propose starting a project to rehabilitate underground steam lines and extend the life of the oldest boiler at the steam facility. This project continues BNL's efforts to correct code and operational safety

Other projects proposed for this planning period include modifications for Life Safety Codes, replacement of halon systems, construction of a new visitor center and abatement of asbestos. Proposed upgrades to facilities and utilities include replacing roofing, extending the Chilled Water capabilities, installing fiber optics, and further modifications to the steam facility. New buildings will be constructed to house the Departments of Applied Science and Advanced Technology.

Inadequate funding for the General Purpose Facilities sub-program is continuing the cycle of having high operating and maintenance costs, rather than securing prudent reductions through increased investment in new facilities. The Laboratory is concerned about the inability of the MEL/FS Program to address these projects and ES&H projects while dealing with issues of core infrastructure.

The anticipated MEL/FS Line Item requirements from FY 1998 to FY 2003 are approximately $112.8 Million. Based on a ten-year average funding level of $5.5 Million, a $ 77.8 Million shortfall is expected.

Facilities Plans and Options:

These low funding levels will challenge the Laboratory's ability to improve infrastructure. At the same time, operating costs certainly will increase, as the maintenance of various aged buildings and utility systems becomes more difficult. The consolidation of staff accommodations, both in the scientific and support areas, will continue to be delayed, and the thrust of future initiatives will be affected by the Laboratory's ability to provide a working environment consistent with the quality personnel it must attract.

BNL has developed strategies, listed below, to meet the challenges of maintaining old deteriorated wood-frame structures and aged utility systems in a period of static or declining budgets.

- Establishment of a system of project prioritization involving senior management, to maximize the use of project funds for the Laboratory's strategic goals. The top priority infrastructure projects include the following:

  FY 1999 Line Item to replace sewer lines and improve the Sanitary Sewer system;

  FY 2000 Line item to replace underground steam distribution lines;

  FY 2000 Line item to replace damaged underground feeders and malfunctioning circuit breaker mechanisms.

- Evaluation of options for electrical power, including competitive procurement, and extending or renegotiating the NYPA contract.

- Formation of Planning Teams to identify and analyze issues related to buildings and utilities. These issues will be communicated to management, along with proposed actions to identify capital- and operating-funded projects and their potential impacts.

- Implementation of a space-charge program to identify space that is uneconomical to maintain, and, thus, can be demolished or mothballed, resulting in operational savings.
- Evaluation of third-party funding to develop new office and laboratory space. With continuing declines in federal infrastructure budgets, the prospect of traditionally funded capital renewal through MEL/FS and GPP programs is remote. These programs are dominated by high priority ESH&H needs. Third party financing may be the only viable alternative to achieve the large scale replacement of infrastructure needed to sustain BNL. A project concept was developed which would give approximately 500,000 square feet of new office and laboratory space. Over 700,000 square feet associated with 35 buildings would be demolished. A new housing area would be included in the project.
- Development of plans to consolidate workspace for personnel which will allow unsatisfactory wood buildings to be vacated and either mothballed or demolished.
- Analyze make-or-buy options for Laboratory support operations adjusting them to reflect the most cost-effective solutions.

As new programmatic initiatives are completed, such as RHIC, the Laboratory will experience a large influx of users, collaborators, and visitors, creating an increased demand for suitable workspace, and support services. This will be offset, but only in part, by reductions in some programs and associated support staff due to reductions in budgets, consolidation of functions, and initiatives in overhead cost cutting. Several projects are needed to further consolidate major scientific departments and support functions currently dispersed throughout the site, including Users facilities for RHIC and the NSLS, and a facility for support organizations. All these proposed efforts are consistent with the efforts to improve the Laboratory's research environment, decrease future ES&H liabilities, and eliminate older wooden structures, which were constructed more than 50 years ago as temporary facilities. MEL/FS and Program Construction Resource Projections are provided in Section 6, Tables 12 and 13.

Table 3 – ESH, Infrastructure and Environmental Management Resource Projections

Environmental, Safety, Health and Infrastructure Resource Projection (a) (FY 98 Dollars in Millions)						
FUNDING	**FY98**	**FY99**	**FY00**	**FY01**	**FY02**	**FY03**
ESH Operating						
Laboratory	1.7	3.1	1.5	(b)	(b)	(b)
Department & Division	39.4	42.3	35.4	32.8	33.9	(b)
ESH Capital Equipment	0.4	0.3	0.1	(b)	(b)	(b)
ESH Line Item	0.6	0.5	4.0	17.3	10.3	10.0
ESH GPP						
Landlord	4.3	4.0	3.2	(b)	(b)	(b)
KA	0.1	0.4	0.0	(b)	(b)	(b)
KB	0.0	0.0	0.0	(b)	(b)	(b)
KC	1.1	0.9	0.1	(b)	(b)	(b)
ESH AIP						
KA	0.0	0.0	0.0	(b)	(b)	(b)
KB	0.0	0.0	0.0	(b)	(b)	(b)
KC	0.8	1.3	1.2	(b)	(b)	(b)
KP	0.0	0.0	0.0	(b)	(b)	(b)
Infrastructure Line Item	0.0	0.8	4.5	14.9	5.0	10.0
Infrastructure GPP	2.0	1.7	3.3	(b)	(b)	(b)
KP						
Restoration (EM-40)						
Remedial Actions	16.8	12.1	14.6	17.2	15.5	15.2
Decontamination and Decommissioning of BGRR	0.1	0	0	4.1	6.1	15.5
Legacy Waste Disposal	0.9	3.2	4.4			
Program Management	3.3	2.5	2.5	2.5	2.6	2.4
Waste Management Operations (EM-30)	5.5	5.8	5.8	5.9	6.1	6.3

(a) Details are provided in the Brookhaven National Laboratory Draft ES&H and Infrastructure management Plan, May 1998.

(b) To be determined.

Table 4 – BNL Building Area

	Quantity	Gross Area
BNL Buildings	343	376,587 gsm (4,053,548 gsf)
Leased	1	93 gsm (1,000 gsf)
Portable Structures	353	10,785 gsm (116,085 gsf)
TOTAL	697	387,465 gsm (4,170,639 gsf)

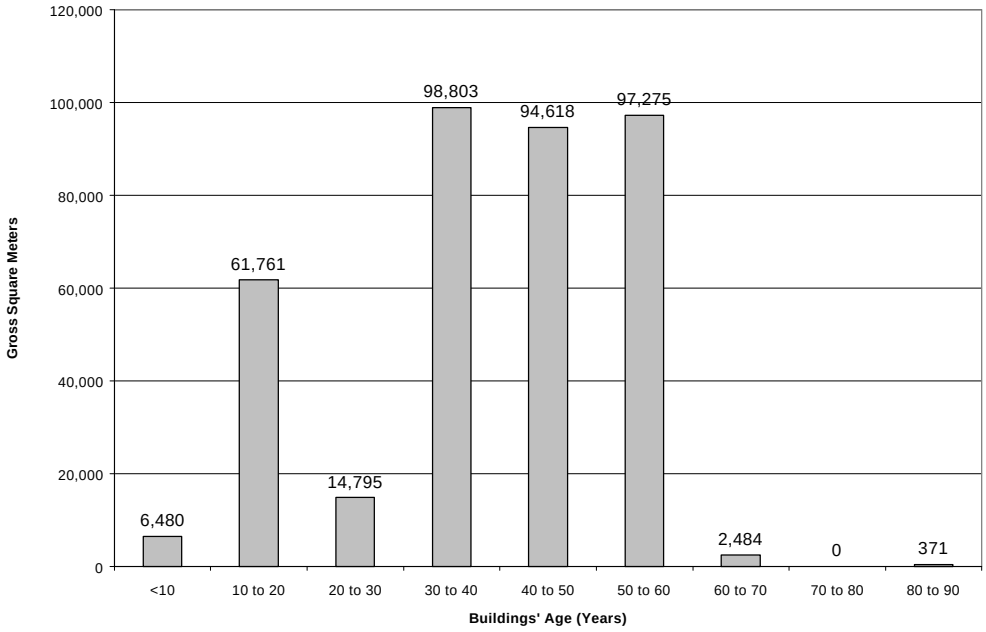
Table 5 – Replacement Value

Facility Type	Value (Million $)
Buildings	3,329
OSF	592
Total	3,921

Table 6 – Inactive Surplus Facilities Plan

BUILDING NAME	FIMS ASSET #	DOE SPONSOR	PROGRAM FOR DEMOLITION
Well #1	**0093**	**None**	**ER**
Technical Photography	0118	None	ER
Well #2	0168	None	ER
Old Incinerator	0195	None	ER
Sheet Metal Shop	0207	None	ER
Storage	0208	None	ER
Oceanographic Sciences	0318	None	ER
Incinerator	0428	None	ER
Chemical Storage	0444	EM-30	EM-40
Administration	0445	EM-30	EM-40
Waste Compaction	0446	EM-30	EM-40
Storage Rigging	0447	EM-30	EM-40
Nuclear Waste Storage	0448	EM-30	EM-40
Radioactive Storage	0650A	None	ER
BGRR	0702	None	EM-40
Instrument House	0708	None	EM-40
Canal House	0709	None	EM-40
Gamma Pool	0830 (Partial)	None	ER
Former 7' Bubble Chamber	0960	None	ER

Figure 2 – Age of Laboratory Buildings



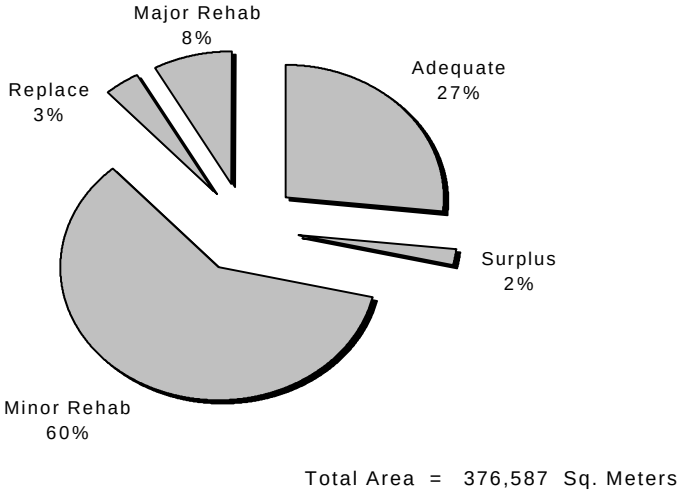
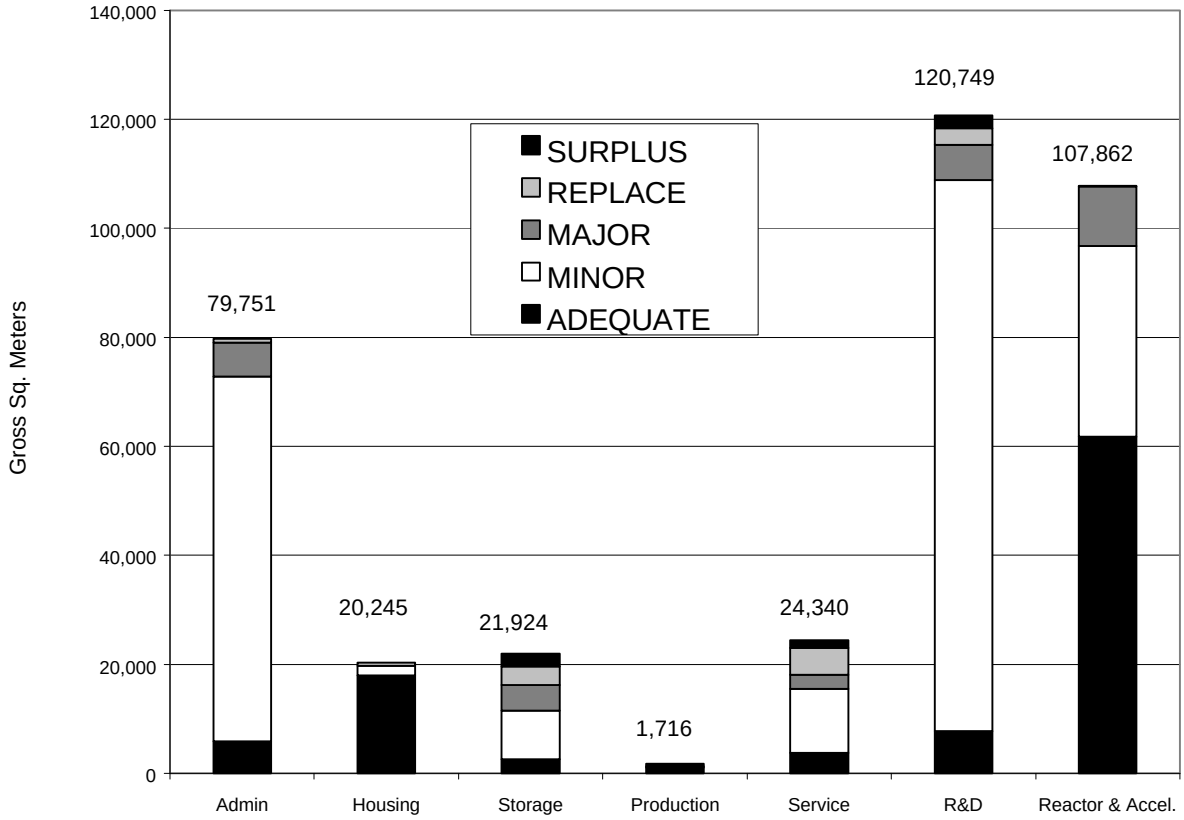


Figure 3 – Condition of Laboratory Space

	ADEQUATE	MINOR REHAB REQUIRED	MAJOR REHAB REQUIRED	REPLACE	SURPLUS	TOTAL
Admin	5,873	66,980	6,153	745	0	79,751
Housing	17,954	1,793	0	498	0	20,245
Storage	2,568	8,901	4,714	3,388	2,353	21,924
Production	1,044	177	0	0	495	1,716
Service	3,776	11,709	2,631	4,891	1,333	24,340
R&D	7,764	101,130	6,402	3,157	2,296	120,749
Reactor & Accel.	61,798	34,963	10,943	0	158	107,862
	100,777	**225,653**	**31,843**	**12,679**	**6,635**	**376,587**

Figure 4 – Use and Condition of Space



6. Resource Projections

The resource projections do not include the Laboratory and program initiatives described in Section 4 unless those initiatives were part of the FY 2000 Budget Submission.

Table 7 - LABORATORY FUNDING SUMMARY
($ IN MILLIONS IN BUDGET AUTHORITY)

	FY 97	FY 98	FY 99	FY 00*	FY 01**	FY 02**	FY 03**
DOE EFFORT	254.0	261.2	295.6	299.6	299.3	293.5	293.3
WORK FOR OTHER THAN DOE	45.5	40.7	51.2	53.7	48.6	42.6	42.6
TOTAL OPERATING	299.5	301.9	346.8	353.3	347.9	336.1	335.9
CAPITAL EQUIPMENT	15.6	26.0	30.6	30.5	30.2	30.1	30.1
PROGRAM CONSTRUCTION	82.8	63.3	26.2	24.9	53.1	54.3	33.7
GENERAL PURPOSE EQUIP.	2.0	1.8	4.0	4.0	5.5	5.5	5.5
GENERAL PLANT PROJECTS(GPP)	5.2	8.3	9.0	8.4	8.3	8.3	8.3
TOTAL LABORATORY FUNDING	**405.1**	**401.3**	**416.6**	**421.1**	**445.0**	**434.3**	**413.5**

* ESCALATION FACTORS: FY2000 OPERATING COSTS AT 3.5%
** CONSTANT FY2000 DOLLARS

Table 8 - LABORATORY PERSONNEL SUMMARY
(PERSONNEL IN FTE)

	FY 97	FY 98	FY 99	FY 00	FY 01	FY 02	FY 03
DIRECT							
DOE EFFORT	1502	1463	1401	1331	1370	1390	1361
WORK FOR OTHER THAN DOE	216	212	238	248	216	211	204
TOTAL DIRECT	1718	1675	1639	1579	1586	1601	1565
TOTAL ORG. BURDEN	184	190	179	177	177	177	177
LABORATORY DIRECTED R&D	15	18	22	22	22	22	22
TOTAL MATERIAL BURDEN	85	82	80	78	78	78	78
ALLOCATED SERVICES	549	547	543	540	540	540	540
TOTAL INDIRECT	556	545	540	535	535	535	532
TOTAL LABORATORY PERSONNEL	**3107**	**3057**	**3003**	**2931**	**2938**	**2953**	**2914**

Table 9 FUNDING BY ASSISTANT SECRETATIAL OFFICE

($ IN MILLIONS IN BUDGET AUTHORITY)

	FY 97	FY 98	FY 99	FY 00*	FY 01**	FY 02**	FY 03**
DEPARTMENT OF ENERGY PROGRAMS							
DIRECTOR, OFFICE OF ENERGY RESEARCH							
OPERATING	199.2	204.5	232.3	239.5	239.5	240.7	240.5
INVENTORIES	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CAPITAL EQUIPMENT	14.3	24.5	29.7	28.8	29.5	29.4	29.4
GENERAL PURPOSE EQUIPMENT (GPE)	2.0	1.8	4.0	4.0	5.5	5.5	5.5
GENERAL PLANT PROJECTS (GPP)	5.2	8.3	9.0	8.4	8.3	8.3	8.3
CONSTRUCTION	82.5	63.3	20.7	13.6	44.6	49.8	33.7
TOTAL	**303.2**	**302.4**	**295.7**	**294.3**	**327.4**	**333.7**	**317.4**
A/S CONSERVATION & RENEWABLE ENERGY							
OPERATING	4.2	4.3	7.0	7.3	6.9	6.9	6.9
CAPITAL EQUIPMENT	0.0	0.0	0.2	0.2	0.2	0.2	0.2
TOTAL	**4.2**	**4.3**	**7.2**	**7.5**	**7.1**	**7.1**	**7.1**
A/S ENVIRONMENT, SAFETY & HEALTH							
OPERATING	**3.4**	**3.1**	**1.8**	**1.1**	**1.2**	**1.2**	**1.2**
A/S NONPROLIF. AND NATIONAL SECURITY							
OPERATING	**13.4**	**16.7**	**15.6**	**12.3**	**12.3**	**12.3**	**12.3**
A/S, DEFENSE PROGRAMS							
OPERATING	**3.8**	**2.3**	**2.0**	**2.1**	**2.1**	**2.1**	**2.1**
A/S, ENVIRON. RESTORATION AND WASTE MGMT.							
OPERATING	27.3	26.8	31.6	32.0	32.0	25.0	25.0
CAPITAL EQUIPMENT	0.4	0.4	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION	0.3	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	**27.6**	**26.8**	**31.6**	**32.0**	**32.0**	**25.0**	**25.0**
A/S, FOSSIL ENERGY							
OPERATING	0.9	1.0	1.5	1.5	1.5	1.5	1.5
CAPITAL EQUIPMENT	0.0	0.0	0.2	0.3	0.3	0.3	0.3
TOTAL	**0.9**	**1.0**	**1.7**	**1.8**	**1.8**	**1.8**	**1.8**
OFFICE OF NUCLEAR ENERGY							
OPERATING	**1.6**	**2.4**	**2.2**	**2.4**	**2.4**	**2.4**	**2.4**
OFFICE, SCIENCE EDUCATION/TECHNICAL INFO.							
OPERATING	**0.0**	**0.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**
OFFICE, POLICY PLANNING AND ANALYSIS							
OPERATING	**0.2**	**0.1**	**0.6**	**0.4**	**0.4**	**0.4**	**0.4**
TOTALS-DOE PROGRAMS							
OPERATING	254.0	261.2	295.6	299.6	299.3	293.5	293.3
INVENTORIES	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CAPITAL EQUIPMENT	14.7	24.9	30.1	29.3	30.0	29.9	29.9
PROGRAM CONSTRUCTION	82.8	63.3	20.7	13.6	44.6	49.8	33.7
GENERAL PURPOSE EQUIPMENT (GPE)	2.0	1.8	4.0	4.0	5.5	5.5	5.5
GENERAL PLANT PROJECTS (GPP)	5.2	8.3	9.0	8.4	8.3	8.3	8.3
TOTAL	**358.7**	**359.5**	**359.4**	**354.9**	**387.7**	**387.0**	**370.7**

* ESCALATION FACTORS: FY2000 OPERATING COSTS AT 3.5% ** CONSTANT FY2000 DOLLARS

Table 9 (continued)

($ IN MILLIONS IN BUDGET AUTHORITY)

	FY 97	FY 98	FY 99*	FY 00*	FY 01**	FY 02**	FY 03**
WORK FOR OTHER THAN DOE							
NUCLEAR REGULATORY COMMISSION							
OPERATING	8.6	7.6	5.5	5.5	5.5	5.5	5.5
DEPARTMENT OF DEFENSE							
OPERATING	1.6	1.3	1.5	1.6	1.6	1.6	1.6
NAT'L AERONAUTICS AND SPACE ADMIN.							
OPERATING	1.5	1.8	1.8	1.8	1.8	1.8	1.8
CAPITAL	0.0	0.1	0.1	0.1	0.1	0.1	0.1
CONSTRUCTION - BOOSTER APPL. FACILITY	0.0	0.0	5.5	11.3	8.5	4.5	0.0
TOTAL	**1.5**	**1.9**	**7.4**	**13.2**	**10.4**	**6.4**	**1.9**
DEPARTMENT OF STATE							
OPERATING	7.5	2.7	7.0	7.0	7.0	7.0	7.0
NATIONAL SCIENCE FOUNDATION							
OPERATING	1.3	1.0	1.0	0.2	0.2	0.2	0.2
DEPARTMENT OF HEALTH AND HUMAN SVCES.							
OPERATING	4.9	6.1	6.1	6.1	6.1	6.1	6.1
ENVIRONMENTAL PROTECTION AGENCY							
OPERATING	2.8	3.3	3.4	3.4	3.4	3.4	3.4
OTHER FEDERAL AGENCIES							
OPERATING	1.9	0.8	1.0	1.0	1.0	1.0	1.0
CAPITAL	0.0	0.1	0.1	0.1	0.1	0.1	0.1
TOTAL	**1.9**	**0.9**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**
OTHER DOE LABS							
OPERATING	12.4	12.6	20.9	24.1	19.0	13.0	13.0
CAPITAL	0.9	0.9	0.3	1.0	0.0	0.0	0.0
TOTAL	**13.3**	**13.5**	**21.2**	**25.1**	**19.0**	**13.0**	**13.0**
ALL OTHERS							
OPERATING	3.0	3.5	3.0	3.0	3.0	3.0	3.0
CAPITAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	**3.0**	**3.5**	**3.0**	**3.0**	**3.0**	**3.0**	**3.0**
TOTALS-WORK FOR OTHER THAN DOE							
OPERATING	45.5	40.7	51.2	53.7	48.6	42.6	42.6
CAPITAL	0.9	1.1	0.5	1.2	0.2	0.2	0.2
CONSTRUCTION	0.0	0.0	5.5	11.3	8.5	4.5	0.0
TOTAL	**46.4**	**41.8**	**57.2**	**66.2**	**57.3**	**47.3**	**42.8**
LABORATORY TOTALS							
OPERATING	299.5	301.9	346.8	353.3	347.9	336.1	335.9
INVENTORIES	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CAPITAL EQUIPMENT	15.6	26.0	30.6	30.5	30.2	30.1	30.1
PROGRAM CONSTRUCTION	82.8	63.3	26.2	24.9	53.1	54.3	33.7
GENERAL PURPOSE EQUIPMENT (GPE)	2.0	1.8	4.0	4.0	5.5	5.5	5.5
GENERAL PLANT PROJECTS (GPP)	5.2	8.3	9.0	8.4	8.3	8.3	8.3
TOTAL	**405.1**	**401.3**	**416.6**	**421.1**	**445.0**	**434.3**	**413.5**

* ESCALATION FACTORS: FY1999 AND 2000 OPERATING COSTS AT 3.5%

** CONSTANT FY2000 DOLLARS

Table 10 LABORATORY PERSONNEL SUMMARY
(PERSONNEL IN FTE)

	FY1997	FY1998	FY1999	FY 2000	FY 2001	FY 2002	FY2003
DEPARTMENT OF ENERGY PROGRAMS							
DIRECTOR, OFFICE OF ENERGY RESEARCH	1338	1308	1240	1171	1208	1228	1199
A/S CONSERVATION & RENEWABLE ENERGY	22	14	23	25	24	24	24
A/S ENVIRONMENT, SAFETY & HEALTH	17	12	9	9	9	9	9
A/S, NUCLEAR ENERGY	5	7	8	7	8	8	8
A/S, NONPROLIFERATION AND NATIONAL SECURITY	33	42	38	36	36	36	36
A/S, DEFENSE PROGRAMS	14	11	8	8	8	8	8
A/S ENVIRONMNTL. RESTORATION & WASTE MGMT.	67	62	64	64	66	66	66
A/S, FOSSIL ENERGY	5	6	7	7	7	7	7
OFFICE, SCIENCE EDUCATION AND TECHNICAL INFO.	0	0	3	3	3	3	3
OFFICE, POLICY, PLANNING, AND ANALYSIS	1	1	1	1	1	1	1
TOTAL DOE PROGRAMS	1502	1463	1401	1331	1370	1390	1361
WORK FOR OTHER THAN DOE							
NUCLEAR REGULATORY COMMISSION	39	34	36	33	33	33	33
DEPARTMENT OF DEFENSE	11	9	9	8	8	8	8
DEPARTMENT OF STATE	4	4	4	4	4	4	4
NAT'L AERONAUTICS AND SPACE ADMINISTRATION	6	5	18	25	20	15	8
DEPARTMENT OF HEALTH AND HUMAN SERVICES	28	28	28	26	26	26	26
NATIONAL SCIENCE FOUNDATION	6	5	6	1	1	1	1
ENVIRONMENTAL PROTECTION AGENCY	9	5	5	5	5	5	5
OTHER FEDERAL AGENCIES	5	5	7	7	7	7	7
OTHER DOE LABS	70	57	75	89	62	62	62
ALL OTHERS	38	60	50	50	50	50	50
TOTAL WORK FOR OTHER THAN DOE	**216**	**212**	**238**	**248**	**216**	**211**	**204**
TOTAL LABORATORY-DIRECT	**1718**	**1675**	**1639**	**1579**	**1586**	**1601**	**1565**
TOTAL ORGANIZATIONAL BURDEN	184	190	179	177	177	177	177
LABORATORY DIRECTED R&D	15	18	22	22	22	22	22
TOTAL MATERIAL BURDEN	85	82	80	78	78	78	78
DISTRIBUTED/ALLOCATED SERVICES	549	547	543	540	540	540	540
TOTAL INDIRECT	556	545	540	535	535	535	532
TOTAL LABORATORY-PERSONNEL	3107	3057	3003	2931	2938	2953	2914

Table 11 FUNDING BY ASSISTANT SECRETARIAL LEVEL OFFICE (IN MILLIONS IN BUDGET AUTHORITY)	FY 97	FY 98	FY 99	FY 00*	FY 01**	FY 02**	FY 03**
DEPARTMENT OF ENERGY PROGRAMS							
DIRECTOR, OFFICE OF ENERGY RESEARCH							
AT-15 DEVELOPMENT & TECHNOLOGY							
OPERATING	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**
DIRECT PERSONNEL	**1**	**1**	**1**	**1**	**1**	**1**	**1**
KA-02 FACILITY OPERATIONS							
OPERATING	47.0	51.9	35.1	12.0	12.0	12.0	12.0
CHANGES IN INVENTORIES	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CAPITAL EQUIPMENT	2.0	9.6	11.9	8.5	9.0	9.0	9.0
GENERAL PURPOSE EQUIPMENT (GPE)	2.0	1.8	4.0	4.0	5.5	5.5	5.5
GENERAL PLANT PROJECTS (GPP)	5.2	6.3	5.4	5.3	5.3	5.3	5.3
CONSTRUCTION (AIP)	1.9	0.9					
TOTAL FUNDING	**58.1**	**70.5**	**56.4**	**29.8**	**31.8**	**31.8**	**31.8**
DIRECT PERSONNEL	**248**	**258**	**224**	**77**	**77**	**77**	**77**
KA-04 RESEARCH AND TECHNOLOGY							
OPERATING	16.9	16.3	14.3	15.5	15.5	16.5	16.5
CAPITAL EQUIPMENT	1.1	0.0	0.2	0.3	0.3	0.3	0.3
TOTAL FUNDING	**18.0**	**16.3**	**14.5**	**15.8**	**15.8**	**16.8**	**16.8**
DIRECT PERSONNEL	**101**	**82**	**75**	**80**	**80**	**80**	**80**
KA HIGH ENERGY PHYSICS							
OPERATING	63.9	68.2	49.4	27.5	27.5	28.5	28.5
CHANGES IN INVENTORIES	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CAPITAL EQUIPMENT	3.1	9.6	12.1	8.8	9.3	9.3	9.3
GENERAL PURPOSE EQUIPMENT (GPE)	2.0	1.8	4.0	4.0	5.5	5.5	5.5
GENERAL PLANT PROJECTS (GPP)	5.2	6.3	5.4	5.3	5.3	5.3	5.3
CONSTRUCTION (AIP)	1.9	0.9	0.0	0.0	0.0	0.0	0.0
TOTAL FUNDING	**76.1**	**86.8**	**70.9**	**45.6**	**47.6**	**48.6**	**48.6**
DIRECT PERSONNEL	**349**	**340**	**299**	**157**	**157**	**157**	**157**
KB-01 MEDIUM ENERGY PHYSICS							
OPERATING	2.7	3.0	2.3	3.1	3.1	3.1	3.1
CAPITAL EQUIPMENT	0.9	1.2	0.3	1.0	1.0	1.0	1.0
TOTAL FUNDING	**3.6**	**4.2**	**2.6**	**4.1**	**4.1**	**4.1**	**4.1**
DIRECT PERSONNEL	**15**	**16**	**13**	**18**	**18**	**18**	**18**
KB-02 HEAVY ION PHYSICS							
PHYSICS RESEARCH	6.7	6.9	7.0	7.0	7.0	7.0	7.0
FACILITY OPERATIONS							
AGS/TVDG OPERATIONS	7.5	5.0	6.2	2.5	2.5	2.5	2.5
RHIC PRE-OPS/ INVENTORY	7.5	19.0	34.5				
RHIC COMPUTING	0.3	0.9	1.2				
RHIC OPERATIONS			31.5	96.5	96.5	96.5	96.5
TOTAL FACILITY OPERATIONS	15.3	24.9	73.4	99.0	99.0	99.0	99.0
TOTAL OPERATING	22.0	31.8	80.4	106.0	106.0	106.0	106.0
CAPITAL-AEE	6.4	6.3	3.9	6.0	5.1		
CAPITAL-GENERAL	0.4	1.3	8.2	5.9	5.9	5.9	5.9
CAPITAL-NEW EXPERIMENTS					1.0	6.0	6.0
TOTAL CAPITAL	6.8	7.6	12.1	11.9	12.0	11.9	11.9
GENERAL PLANT PROJECTS		0.5	1.3	1.4	1.0	1.0	1.0
CONSTRUCTION (AIP)	1.8	1.3	1.3	3.1	4.0	4.0	4.0
CONSTRUCTION (RHIC) (a)	65.0	59.4	16.6				
TOTAL CONSTRUCTION	66.8	61.2	19.2	4.5	5.0	5.0	5.0
TOTAL FUNDING	**95.6**	**100.6**	**111.7**	**122.4**	**123.0**	**122.9**	**122.9**
DIRECT PERSONNEL	**443**	**461**	**441**	**488**	**500**	**500**	**500**

(a)Funded
*** Escalation Factors: FY 2000 Operating Costs at 3.5%**
**** Constant FY 2000 Dollars**

Table 11 (continued)
(IN MILLIONS IN BUDGET AUTHORITY)

	FY 97	FY 98	FY 99	FY 00*	FY 01**	FY 02**	FY 03**
KB-03 NUCLEAR THEORY							
OPERATING	1.0	1.1	1.0	1.0	1.0	1.0	1.0
DIRECT PERSONNEL	**6**	**6**	**6**	**6**	**6**	**6**	**6**
KB-04 LOW ENERGY PHYSICS							
OPERATING	**2.8**	**3.0**	**3.0**	**3.0**	**3.0**	**3.0**	**3.0**
DIRECT PERSONNEL	**14**	**13**	**14**	**14**	**14**	**14**	**14**
KB NUCLEAR PHYSICS							
OPERATING	28.5	38.9	86.7	113.1	113.1	113.1	113.1
CAPITAL EQUIPMENT	7.7	8.8	12.4	12.9	13.0	12.9	12.9
GENERAL PLANT PROJECTS	0.0	0.5	1.3	1.4	1.0	1.0	1.0
CONSTRUCTION (AIP)	1.8	1.3	1.3	3.1	4.0	4.0	4.0
CONSTRUCTION (RHIC) (a)	65.0	59.4	16.6	0.0	0.0	0.0	0.0
TOTAL CONSTRUCTION	66.8	61.2	19.2	4.5	5.0	5.0	5.0
TOTAL FUNDING	**103.0**	**108.9**	**118.3**	**130.5**	**131.1**	**131.0**	**131.0**
DIRECT PERSONNEL	**478**	**496**	**474**	**526**	**538**	**538**	**538**
KC-02 MATERIALS SCIENCES							
OPERATING (RESEARCH)	**9.3**	10.1	10.6	11.0	11.0	11.0	11.00
NSLS OPERATIONS	17.4	20.3	20.6	20.6	20.6	20.6	20.6
HFBR OPERATIONS	**34.7**	**22.0**	**22.9**	**22.9**	**22.9**	**22.9**	**22.9**
TOTAL OPERATING	61.4	52.4	54.1	54.5	54.5	54.5	54.5
CHANGES IN INVENTORIES							
CAPITAL EQUIPMENT	1.9	2.1	3.7	3.7	3.7	3.7	3.7
CONSTRUCTION							
GENERAL PLANT PROJECTS		1.5	1.7	1.0	1.0	1.0	1.0
CONSTRUCTION (ARAM)	**1.3**	1.1	1.5	2.0	2.0	2.0	2.0
NSLS PHASE-III UPGRADE (b)				0.0	8.5	18.5	6.7
TOTAL CONSTRUCTION	**1.3**	**2.6**	**3.2**	**3.0**	**11.5**	**21.5**	**9.7**
TOTAL FUNDING	**64.6**	**57.1**	**61.0**	**61.2**	**69.7**	**79.7**	**67.9**
DIRECT PERSONNEL	**274**	**249**	**254**	**254**	**274**	**294**	**268**
KC-03 CHEMICAL SCIENCES							
OPERATING (RESEARCH)	8.1	8.6	8.3	9.0	9.0	9.0	9.0
NSLS OPERATIONS	7.4	7.4	7.7	8.0	8.0	8.0	8.0
TOTAL OPERATING	15.5	16.0	16.0	17.0	17.0	17.0	17.0
CHANGES IN INVENTORIES	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CAPITAL EQUIPMENT	1.0	1.5	1.0	2.1	2.1	2.1	2.1
TOTAL FUNDING	**16.5**	**17.5**	**17.0**	**19.1**	**19.1**	**19.1**	**19.1**
DIRECT PERSONNEL	**86**	**86**	**79**	**85**	**85**	**85**	**85**
KC-04 ENGINEERING & GEOSCIENCES							
OPERATING	0.3	0.6	0.4	0.4	0.4	0.4	0.4
CAPITAL EQUIPMENT		0.1	0.1	0.3	0.3	0.3	0.3
TOTAL FUNDING	**0.3**	**0.7**	**0.5**	**0.7**	**0.7**	**0.7**	**0.7**
DIRECT PERSONNEL	**2**	**2**	**3**	**3**	**3**	**3**	**3**
KC-06 ENERGY BIOSCIENCES							
OPERATING	1.1	1.2	1.0	1.1	1.1	1.1	1.1
CAPITAL EQUIPMENT	0.1	0.1	0.1	0.1	0.1	0.1	0.1
TOTAL FUNDING	**1.2**	**1.3**	**1.1**	**1.2**	**1.2**	**1.2**	**1.2**
DIRECT PERSONNEL	**6**	**5**	**4**	**5**	**5**	**5**	**5**

(a) FUNDED
(b) PROPOSED
*** ESCALATION FACTORS: FY2000 OPERATING COSTS AT 3.5%**
**** CONSTANT FY2000 DOLLARS**

Table 11 (continued)
(IN MILLIONS IN BUDGET AUTHORITY)

	FY 97	FY 98	FY 99	FY 00*	FY 01**	FY 02**	FY 03**
KC BASIC ENERGY SCIENCES							
OPERATING (RESEARCH)	18.8	20.6	20.3	21.5	21.5	21.5	21.5
NSLS OPERATIONS	24.8	27.7	28.3	28.6	28.6	28.6	28.6
HFBR OPERATIONS	34.7	22.0	22.9	22.9	22.9	22.9	22.9
TOTAL OPERATING	78.3	70.3	71.5	73.0	73.0	73.0	73.0
CHANGES IN INVENTORIES	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CAPITAL EQUIPMENT	3.0	3.7	4.9	6.2	6.2	6.2	6.2
CONSTRUCTION							
GENERAL PLANT PROJECTS	0.0	1.5	1.7	1.0	1.0	1.0	1.0
CONSTRUCTION (ARAM)	1.3	1.1	1.5	2.0	2.0	2.0	2.0
NSLS PHASE-III UPGRADE (b)	0.0	0.0	0.0	0.0	8.5	18.5	6.7
TOTAL CONSTRUCTION	1.3	2.6	3.2	3.0	11.5	21.5	9.7
TOTAL FUNDING	**82.6**	**76.6**	**79.6**	**82.2**	**90.7**	**100.7**	**88.9**
DIRECT PERSONNEL	**368**	**342**	**340**	**347**	**367**	**387**	**361**
KG MULTIPROGRAM ENERGY LABS							
CONSTRUCTION	11.1	0.6	1.3	8.5	30.1	25.3	21.0
TOTAL FUNDING	**11.1**	**0.6**	**1.3**	**8.5**	**30.1**	**25.3**	**21.0**
DIRECT PERSONNEL	**-**	**1**	**2**	**10**	**15**	**15**	**12**
KP BIOLOGICAL & ENVIRONMENTAL RESEARCH							
OPERATING	24.4	24.1	22.0	23.0	23.0	23.0	23.0
CAPITAL EQUIPMENT	0.5	2.4	0.3	0.9	1.0	1.0	1.0
GENERAL PLANT PROJECTS			0.6	0.7	1.0	1.0	1.0
CONSTRUCTION (AIP)	1.4						
TOTAL FUNDING	**26.3**	**26.5**	**22.9**	**24.6**	**25.0**	**25.0**	**25.0**
DIRECT PERSONNEL	**123**	**112**	**108**	**112**	**112**	**112**	**112**
KJ COMP. AND TECH. RESEARCH							
OPERATING	**4.0**	**2.9**	**2.6**	**2.8**	**2.8**	**3.0**	**2.8**
DIRECT PERSONNEL	**19**	**16**	**16**	**18**	**18**	**18**	**18**
TOTALS-ENERGY RESEARCH							
TOTAL OPERATING	199.2	204.5	232.3	239.5	239.5	240.7	240.5
CHANGE IN INVENTORIES	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CAPITAL EQUIPMENT	14.3	24.5	29.7	28.8	29.5	29.4	29.4
GENERAL PURPOSE EQUIPMENT (GPE)	2.0	1.8	4.0	4.0	5.5	5.5	5.5
GENERAL PLANT PROJECTS	5.2	8.3	9.0	8.4	8.3	8.3	8.3
CONSTRUCTION	82.5	63.3	20.7	13.6	44.6	49.8	33.7
TOTAL FUNDING	**303.2**	**302.4**	**295.7**	**294.3**	**327.4**	**333.7**	**317.4**
DIRECT PERSONNEL	**1338**	**1308**	**1240**	**1171**	**1208**	**1228**	**1199**

(b) PROPOSED
*** ESCALATION FACTORS: FY2000 OPERATING COSTS AT 3.5%**
**** CONSTANT FY2000 DOLLARS**

Table 11 (continued)
(IN MILLIONS IN BUDGET AUTHORITY)

	FY 97	FY 98	FY 99	FY 00*	FY 01**	FY 02**	FY 03**
A/S, CONSERVATION & RENEWABLE ENERGY							
EB SOLAR AND RENEWABLE RES./TECH							
OPERATING	1.9	0.8	2.3	2.4	2.0	2.0	2.0
CAPITAL EQUIPMENT	-	-	0.2	0.2	0.2	0.2	0.2
TOTAL FUNDING	**1.9**	**0.8**	**2.5**	**2.6**	**2.2**	**2.2**	**2.2**
DIRECT PERSONNEL	**13**	**4**	**13**	**13**	**12**	**12**	**12**
EC BUILDINGS AND COMMUNITY SYSTEMS							
OPERATING	**0.4**	**1.2**	**1.2**	**1.3**	**1.3**	**1.3**	**1.3**
DIRECT PERSONNEL	**5**	**5**	**5**	**6**	**6**	**6**	**6**
EE TRANSPORTATION							
OPERATING	**1.9**	**2.3**	**3.5**	**3.6**	**3.6**	**3.6**	**3.6**
DIRECT PERSONNEL	**4**	**5**	**5**	**6**	**6**	**6**	**6**
TOTALS-CONS. & RENEWABLE ENERGY							
OPERATING	4.2	4.3	7.0	7.3	6.9	6.9	6.9
CAPITAL EQUIPMENT	0.0	0.0	0.2	0.2	0.2	0.2	0.2
TOTAL FUNDING	**4.2**	**4.3**	**7.2**	**7.5**	**7.1**	**7.1**	**7.1**
DIRECT PERSONNEL	**22**	**14**	**23**	**25**	**24**	**24**	**24**
A/S, ENVIRONMENT,SAFETY & HEALTH							
HC ENV. ,SAFETY AND HEALTH (NON-DEF.)							
OPERATING	**0.8**	**1.2**	**0.7**	**0.7**	**0.8**	**0.8**	**0.8**
DIRECT PERSONNEL	**5**	**3**	**3**	**3**	**3**	**3**	**3**
HD ENV. ,SAFETY AND HEALTH (DEFENSE)							
OPERATING	**2.6**	**1.9**	**1.1**	**0.4**	**0.4**	**0.4**	**0.4**
DIRECT PERSONNEL	**12**	**9**	**6**	**6**	**6**	**6**	**6**
TOTALS-ENVIRON., SAFETY, AND HEALTH							
OPERATING	**3.4**	**3.1**	**1.8**	**1.1**	**1.2**	**1.2**	**1.2**
DIRECT PERSONNEL	**17**	**12**	**9**	**9**	**9**	**9**	**9**

*** ESCALATION FACTORS: FY2000 OPERATING COSTS AT 3.5%**
**** CONSTANT FY2000 DOLLARS**

Table 11 (continued)
(IN MILLIONS IN BUDGET AUTHORITY)

	FY 97	FY 98	FY 99	FY 00*	FY 01**	FY 02**	FY 03**
A/S, NONPROLIF. AND NATIONAL SECURITY							
GC VERIFICATION R&D							
OPERATING	2.4	1.2	1.2	1.3	1.3	1.3	1.3
DIRECT PERSONNEL	11	9	7	7	7	7	7
GD NUCLEAR SAFEGUARDS & SECURITY							
OPERATING	0.7	0.4	0.8	0.8	0.8	0.8	0.8
DIRECT PERSONNEL	3	2	3	3	3	3	3
GJ ARMS CONTRL. & NONPROLIF.							
OPERATING	10.0	14.8	13.3	10.0	10.0	10.0	10.0
DIRECT PERSONNEL	17	29	26	24	24	24	24
ND EMERGENCY MANAGEMENT							
OPERATING	0.3	0.3	0.3	0.2	0.2	0.2	0.2
DIRECT PERSONNEL	2	2	2	2	2	2	2
TOTALS-NONPROLIF. & NAT'L SEC.							
OPERATING	**13.4**	**16.7**	**15.6**	**12.3**	**12.3**	**12.3**	**12.3**
DIRECT PERSONNEL	**33**	**42**	**38**	**36**	**36**	**36**	**36**
A/S DEFENSE PROGRAMS							
DP OTHER WEAPONS ACTIVITIES							
OPERATING	3.8	2.3	2.0	2.1	2.1	2.1	2.1
DIRECT PERSONNEL	14	11	8	8	8	8	8
A/S ENVIR. RESTOR. AND WST. MGMT.							
EX/EW ENVIR. RESTOR. AND WST. MGMT							
OPERATING	27.3	26.8	31.6	32.0	32.0	25.0	25.0
CAPITAL EQUIPMENT	0.4	0.4					
CONSTRUCTION	0.3						
TOTAL FUNDING	**28.0**	**27.2**	**31.6**	**32.0**	**32.0**	**25.0**	**25.0**
DIRECT PERSONNEL	**67**	**62**	**64**	**64**	**66**	**66**	**66**

*** ESCALATION FACTORS: FY2000 OPERATING COSTS AT 3.5%**
**** CONSTANT FY2000 DOLLARS**

Table 11 (continued)
(IN MILLIONS IN BUDGET AUTHORITY)

	FY97	FY 98	FY 99	FY 00*	FY 01**	FY 02**	FY 03**
A/S, FOSSIL ENERGY							
AA COAL							
OPERATING	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**
DIRECT PERSONNEL	**1**	**1**	**1**	**1**	**1**	**1**	**1**
AC PETROLEUM							
OPERATING	0.6	0.7	1.2	1.2	1.2	1.2	1.2
CAPITAL EQUIPMENT	0.0	0.0	0.2	0.3	0.3	0.3	0.3
TOTAL FUNDING	**0.6**	**0.7**	**1.4**	**1.5**	**1.5**	**1.5**	**1.5**
DIRECT PERSONNEL	**3**	**4**	**5**	**5**	**5**	**5**	**5**
AZ CLEAN COAL							
OPERATING	0.1	0.1	0.1	0.1	0.1	0.1	0.1
DIRECT PERSONNEL	1	1	1	1	1	1	1
TOTALS-FOSSIL ENERGY							
OPERATING	0.9	1.0	1.5	1.5	1.5	1.5	1.5
CAPITAL EQUIPMENT	0.0	0.0	0.2	0.3	0.3	0.3	0.3
TOTAL FUNDING	**0.9**	**1.0**	**1.7**	**1.8**	**1.8**	**1.8**	**1.8**
DIRECT PERSONNEL	**5**	**6**	**7**	**7**	**7**	**7**	**7**
OFFICE OF NUCLEAR ENERGY							
CD URANIUM PROGRAMS							
OPERATING		0.1	0.2	0.2	0.2	0.2	0.2
DIRECT PERSONNEL	-	-	1	1	1	1	1
ST ISOTOPE PROD. & DISTRIBUTION							
OPERATING	1.6	2.3	2.0	2.2	2.2	2.2	2.2
DIRECT PERSONNEL	5	7	7	6	7	7	7
TOTALS-OFFICE OF NUCLEAR ENERGY							
OPERATING	**1.6**	**2.4**	**2.2**	**2.4**	**2.4**	**2.4**	**2.4**
DIRECT PERSONNEL	**5**	**7**	**8**	**7**	**8**	**8**	**8**
OFFICE OF SCIENTIFIC EDU &TECH. INFO.							
KT UNIV. & SCIENCE EDU.							
OPERATING			1.0	1.0	1.0	1.0	1.0
DIRECT PERSONNEL			3	3	3	3	3
OFFICE OF POLICY, PLANNING, AND ANALYSIS							
PE POLICY, ANALYSIS AND SYSTEMS STUDIES							
OPERATING	**0.2**	**0.1**	**0.6**	**0.4**	**0.4**	**0.4**	**0.4**
DIRECT PERSONNEL	**1**	**1**	**1**	**1**	**1**	**1**	**1**

*** ESCALATION FACTORS: FY2000 OPERATING COSTS AT 3.5%**
**** CONSTANT FY2000 DOLLARS**

Table 11 (continued)
(IN MILLIONS IN BUDGET AUTHORITY)

	FY 97	FY 98	FY 99	FY 00*	FY 01**	FY 02**	FY 03**
WORK FOR OTHERS PROGRAMS							
NUCLEAR REGULATORY COMMISSION							
NUCLEAR REACTOR REGULATION							
OPERATING	2.4	2.0	1.5	1.5	1.5	1.5	1.5
DIRECT PERSONNEL	9	9	9	9	9	9	9
NUC. REG. RESEARCH							
OPERATING	5.0	4.7	3.5	3.5	3.5	3.5	3.5
DIRECT PERSONNEL	26	23	23	20	20	20	20
COMMISSION & STAFF OFF.							
OPERATING	1.2	0.9	0.5	0.5	0.5	0.5	0.5
DIRECT PERSONNEL	4	2	4	4	4	4	4
TOTALS-NRC							
OPERATING	**8.6**	**7.6**	**5.5**	**5.5**	**5.5**	**5.5**	**5.5**
DIRECT PERSONNEL	**39**	**34**	**36**	**33**	**33**	**33**	**33**
DEPARTMENT OF STATE							
OPERATING	7.5	2.7	7.0	7.0	7.0	7.0	7.0
DIRECT PERSONNEL	4	4	4	4	4	4	4
DEPARTMENT OF DEFENSE							
OPERATING	1.6	1.3	1.5	1.6	1.6	1.6	1.6
DIRECT PERSONNEL	11	9	9	8	8	8	8
NASA							
OPERATING	1.5	1.8	1.8	1.8	1.8	1.8	1.8
CAPITAL		0.1	0.1	0.1	0.1	0.1	0.1
CONSTRUCTION - BAF			5.5	11.3	8.5	4.5	
TOTAL FUNDING	**1.5**	**1.9**	**7.4**	**13.2**	**10.4**	**6.4**	**1.9**
DIRECT PERSONNEL	**6**	**5**	**18**	**25**	**20**	**15**	**8**
DEPT. HEALTH & HUMAN SERVICES							
OPERATING	4.9	6.1	6.1	6.1	6.1	6.1	6.1
DIRECT PERSONNEL	28	28	28	26	26	26	26
NATIONAL SCIENCE FOUNDATION							
OPERATING	1.3	1.0	1.0	0.2	0.2	0.2	0.2
DIRECT PERSONNEL	6	5	6	1	1	1	1
ENVIRON. PROTECT. AGENCY							
OPERATING	2.8	3.3	3.4	3.4	3.4	3.4	3.4
DIRECT PERSONNEL	9	5	5	5	5	5	5

*** ESCALATION FACTORS: FY2000 OPERATING COSTS AT 3.5%**
**** CONSTANT FY2000 DOLLARS**

Table 11 (continued)
(IN MILLIONS IN BUDGET AUTHORITY)

	FY 97	FY 98	FY 99	FY 00*	FY 01**	FY 02**	FY 03**
OTHER FEDERAL AGENCIES							
OPERATING	1.9	0.8	1.0	1.0	1.0	1.0	1.0
CAPITAL		0.1	0.1	0.1	0.1	0.1	0.1
TOTAL FUNDING	**1.9**	**0.9**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**
DIRECT PERSONNEL	**5**	**5**	**7**	**7**	**7**	**7**	**7**
OTHER DOE LABS							
OPERATING	12.4	12.6	20.9	24.1	19.0	13.0	13.0
CAPITAL	0.9	0.9	0.3	1.0	-	-	-
TOTAL FUNDING	**13.3**	**13.5**	**21.2**	**25.1**	**19.0**	**13.0**	**13.0**
DIRECT PERSONNEL	**70**	**57**	**75**	**89**	**62**	**62**	**62**
ALL OTHERS							
OPERATING	3.0	3.5	3.0	3.0	3.0	3.0	3.0
CAPITAL	-	-	-	-	-	-	-
TOTAL FUNDING	**3.0**	**3.5**	**3.0**	**3.0**	**3.0**	**3.0**	**3.0**
DIRECT PERSONNEL	**38**	**60**	**50**	**50**	**50**	**50**	**50**

*** ESCALATION FACTORS: FY2000 OPERATING COSTS AT 3.5%**
**** CONSTANT FY2000 DOLLARS**

Table 12 - BROOKHAVEN NATIONAL LABORATORY
MAJOR CONSTRUCTION PROJECTS
($ IN MILLIONS IN BUDGET AUTHORITY)

		***** FUNDED *****		** BUDGETED **		******** PROPOSED **********		
	TEC	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
PROGRAM RELATED - ER								
ACCELERATOR IMPROVEMENT PROJECTS (KA)		1.9	0.9	0.0	0.0	0.0	0.0	0.0
ACCELERATOR IMPROVEMENT PROJECTS (KB)		1.8	1.3	1.3	3.1	4.0	4.0	4.0
ACCELERATOR IMPROVEMENT PROJECTS (KC)		1.3	1.1	1.5	2.0	2.0	2.0	2.0
ACCELERATOR IMPROVEMENT PROJECTS (KP)		1.4						
GENERAL PLANT PROJECTS (KA)		5.2	6.3	5.4	5.3	5.3	5.3	5.3
GENERAL PLANT PROJECTS (KB)			0.5	1.3	1.4	1.0	1.0	1.0
GENERAL PLANT PROJECTS (KC)			1.5	1.7	1.0	1.0	1.0	1.0
GENERAL PLANT PROJECTS (KP)				0.6	0.7	1.0	1.0	1.0
RELATIVISTIC HEAVY ION COLLIDER	486.9	65.0	59.4	16.6				
		76.6	71.0	28.4	13.5	14.3	14.3	14.3
PROPOSED CONSTRUCTION - ER								
NSLS PHASE III UPGRADE	33.7					8.5	18.5	6.7
						8.5	18.5	6.7
PROPOSED CONSTRUCTION - NASA								
BOOSTER APPLICATIONS FACILITY	29.8			5.5	11.3	8.5	4.5	
ENVIRONMENTAL RESTORATION/WASTE MGMT		0.3						
UNDER EVALUATION								
RHIC SCIENCE CENTER								
NSLS DUV-FEL FACILITY								
TOTAL FUNDED PROGRAM CONSTRUCTION		76.9	71.0					
TOTAL BUDGETED PROGRAM CONSTRUCTION				33.9	24.8			
TOTAL PROPOSED PROGRAM CONSTRUCTION						31.3	37.3	21.0

Table 13 - BROOKHAVEN NATIONAL LABORATORY
MAJOR CONSTRUCTION PROJECTS
($ IN MILLIONS IN BUDGET AUTHORITY)

			***** FUNDED *****		** BUDGETED **		******** PROPOSED ********		
		TEC	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
MEL/FS PROJECTS	PROJECT TYPE								
FUNDED / BUDGETED									
SANITARY SYSTEM UPGRADE PHASE II	1	4.3	1.0	0.6					
LOSS PREVENTION UPGRADE I	1	7.4	4.3						
HOT LAB RENOVATION BLDG 801PH 1	1	6.6	5.8						
			11.1	0.6	0.0	0.0	0.0	0.0	0.0
PROPOSED KG01									
ELECTRICAL SYSTEM MODS. - PHASE I	3	5.7			0.8	3.9	1.0		
CENTRAL STEAM SYS. REHAB PH. I	3	6.4				0.6	5.8		
ROOF REPLACEMENT – PH 11	3	6.0					6.0		
ELECTRICAL SYSTEM MODS. PHASE II	3	5.0						5.0	
DAT BUILDING PHASE I	5	5.0						5.0	
HIGH-SPEED F.O. INFRASTRUCT. PH. I	3	5.0							5.0
CENTRAL STEAM SYS. REHAB PH. II	3	5.0							5.0
ROOF REPLACEMENT – PH III	3	6.0							6.0
			0.0	0.0	0.8	4.5	12.8	10.0	16.0
PROPOSED KG02									
SANITARY SYSTEM UPGRADE PHASE III	1	6.5			0.5	3.0	3.0		
GROUND & SURFACE WTR PROTECT	1	7.7				1.0	6.7		
SITE SECURITY / VISITOR CENTER	1 & 5	7.6					7.6		
LIFE SAFETY CODE MODS. - PHASE I	1	5.3						5.3	
ASBESTOS PH I	1	5.0						5.0	
HALON SYSTEM REPLACEMENT	1	5.0						5.0	
LIFE SAFETY CODE MODS PHASE II	1	5.0							5.0
			0.0	0.0	0.5	4.0	17.3	15.3	5.0
TOTAL GPF FUNDED CONSTRUCTION			11.1	0.6					
TOTAL GPF BUDGETED CONSTRUCTION					1.3	8.5			
TOTAL GPF PROPOSED CONSTRUCTION							30.1	25.3	21.0
TOTAL FUNDED CONSTRUCTION			88.0	71.6					
TOTAL BUDGETED CONSTRUCTION					35.2	33.3			
TOTAL PF PROPOSED CONSTRUCTION							61.4	62.6	42.0

MEL/FS PROJECT TYPES

1. **ES&H SUPPORT**
2. **BUILDING REHAB & UPGRADE**
3. **UTILITY SYSTEM REHAB & UPGRADE**
4. **ROADS & OSF REHAB & UPGRADE**
5. **NEW BUILDING**

Appendix A

A1 DOE Program Summaries by Program Office

Office of High Energy and Nuclear Physics (HE/NP)

In recent years, DOE's Office of High Energy and Nuclear Physics has sponsored nearly half of the total BNL program. The key elements of this program include the Relativistic Heavy Ion Collider (RHIC) Construction Project; operations of the Alternating Gradient Synchrotron (AGS) user facility; in-house basic research in particle and nuclear physics; and in-house and user research in advanced accelerator concepts and techniques at the BNL Accelerator Test Facility (ATF).

***RHIC Project*:** The RHIC Project has, as its objective, the construction of the world's first relativistic heavy ion collider and a complement of four experimental detectors to carry out frontier research in this exciting new field of nuclear physics. The construction phase will be completed in 1999, and the physics program will start in October 1999. The four complementary detectors, BRAHMS, PHENIX, PHOBOS, and STAR have been designed and constructed to cover important aspects of novel phenomena that are anticipated in this new regime of physics. Topics that will be explored are the birth of the universe at the time of the "big bang"; nuclear physics in the regime of the postulated "quark-gluon plasma"; and the exotic states that matter might result under extraordinary, RHIC-induced circumstances, such as the 'strange matter' that may still exist in the centers of certain white dwarf stars.

***AGS Operations*:** More than 800 users from the United States and abroad perform experiments at the AGS in its two operating modes of proton- and heavy-ion-beam acceleration. In the proton mode, the AGS is the world's highest intensity proton synchrotron and includes a mode for accelerating of polarized protons to 24 GeV. In the heavy-ion mode, the AGS accelerates heavy ions up to gold (Au); Au ions can reach an energy of 11 GeV per nucleon. In a typical user operating cycle for protons, 7 experiments run simultaneously and up to 9 receive beam in a given cycle. During heavy ion runs, typically only 2 or 3 experiments receive beam in a given period. In future, the AGS will become the injector for the RHIC but will still have about 20 hours per day available to continue the fixed-target user program.

***High-Energy and Nuclear Physics Research*:** At BNL, there are five experimental groups in nuclear physics, three experimental groups in particle physics and theory groups in both particle and nuclear physics. These staff work in the Physics Department and their research capabilities are supplemented by small numbers of researchers from the AGS and RHIC Departments. These researchers are active in frontier topics at the cutting edge of contemporary high energy and nuclear physics. The theory programs strongly focus on topics supporting the experimental program but are also active in other areas. The experimenters use the AGS as well as the accelerator facilities at Fermilab and at CERN in Switzerland. When the RHIC program of heavy ion physics commences, BNL researchers will be among the leading groups to use this new facility. All the research programs in which BNL staff participate have clear future directions that represent the most important areas for nuclear and particle physics.

Accelerator Research and Development: The Accelerator Test Facility (ATF) at BNL is a unique user facility for carrying out experiments in advanced particle accelerator theory and technology. The ATF is operated for BNL and outside users by the Center for Accelerator Physics (CAP) that also acts as the focus for BNL's work in accelerator R&D in facilities other than the ATF. Central to the evolution of the CAP is a current strong effort to explore the feasibility and impact that a muon collider facility would bring to the field of particle physics. If technically feasible, it could represent the most cost-effective way to advance the field beyond the reach of the CERN Large Hadron Collider (LHC). BNL is a leader in the Muon Collider Collaboration, a multi-institution R&D group focused on muon-collider R&D.

BNL continues to be the home of the National Nuclear Data Center, a national facility for the collection, evaluation, and dissemination of nuclear cross section and structure data. We will continue to provide quality service to our scientific and technical communities.

Basic Energy Sciences (BES)

The Basic Energy Sciences program is carried out in five departments (Applied Sciences, Biology, Chemistry, NSLS Department, Physics), in the Reactor Division (which oversees the High Flux Beam Reactor), and in the Center for Neutron Science. These programs support the missions of the Divisions of Materials Sciences, Chemical Sciences, Geosciences, and Energy Biosciences in the Office of Basic Energy Sciences in the Department of Energy. This effort represents about 20% of the total program at BNL, and, in particular, supports the major neutron- and photon-user facilities operated by the DOE in the northeast of the United States.

NSLS Operations: Over 2300 users from the United States and abroad perform experiments each year on one of the more than 70 beamlines on the VUV and X-ray rings. Operating for more than 5000 hours per year with an unscheduled downtime of less than 5%, the NSLS presently provides approximately 60% of the total US capacity in synchrotron based research. Experiments are done over an energy range from the far infrared through the ultraviolet and soft-x-ray regions into the hard x-ray region. The size and complexity of the overall program at the NSLS requires the recruitment and retention of a high level accelerator and engineering staff to maintain and to enhance the performance of the source. Similarly, a diverse, expert beamline staff is needed to assure the smooth operation of the users' program and to develop new applications of synchrotron radiation for the community at large. Through the Accelerator Test Facility R&D programs that are being pursued to develop the next generation of synchrotron sources and the deep-UV free electron laser R&D facility at the NSLS we will demonstrate the new science that will be possible with these new sources.

HFBR Operations: As one of the three high-flux-reactor-based neutron sources in the world, the HFBR has been a leading center for neutron science for over 30 years. Its nine ports service 15 instruments which support programs in solid state and nuclear-physics, chemistry, and structural biology. Over the past six years, the HFBR has been upgrading the instrumentation to broaden the range of science that could be addressed. The upgrades include a neutron reflectometer to study polymer interdiffusion and adhesion, and a pair of neutron powder diffraction instruments to determine the structure of materials as diverse as petrochemical catalysts and high-temperature superconductors. A newly developed neutron camera using neutron image plates (now being tested at the

NIST reactor) can provide greatly enhance capabilities for macromolecular crystallography and for studying disordered structures.

The HFBR has been shut down since late 1996, after a tritium plume in the groundwater at levels higher than the drinking water standard was discovered south of the reactor building. The plume was attributed to a small leak of less than 10 gallons per day from the HFBR's spent-fuel storage pool. A Tritium Remediation Project was established to drain the pool and remediate the tritium plume, which is entirely contained within Laboratory boundaries. In addition, in a Conference Report accompanying Public Laws 105-62, the Energy and Water Development Act of 1998, Congress directed that an Environmental Impact Statement (EIS) be prepared for the HFBR. The final decision whether to pursue restart or permanent shutdown (deactivation) of the HFBR will be made by the Secretary of Energy after the EIS is completed in late 1998.

Materials Sciences: There are 13 groups distributed among the Chemistry and Physics Departments, the Department of Applied Science, and the NSLS Department pursuing a broad range of research in metals and ceramics, solid state physics and materials chemistry. Many of these programs are centered around beamlines at the major neutron and synchrotron user facilities. In addition, there is a new 300keV Transmission Electron Microscope facility and several materials preparation and characterization facilities. The principal objective of these programs is to study fundamental interactions in solids, and the role of defects in the macroscopic properties of materials. Current topics of interest include high-temperature superconductivity, magnetism, and the properties of surfaces and adsorbed films. The research includes fundamental studies of the electronic properties using angle and/or spin resolved photoemission and infrared spectroscopy, and of structural and magnetic properties using elastic and inelastic neutron and x-ray scattering and x-ray absorption spectroscopy. These programs are closely coupled with those of the condensed matter theory group, which has made significant contributions to the theory of strongly correlated electron systems, x-ray and neutron scattering, low dimensional magnetism and first principles electronic structure. For example, research into magnetism includes fundamental studies of lower-dimensional magnetic systems; the interplay between electronic, magnetic, and structural degrees of freedom in giant and colossal magnetoresistance materials, and the structure-sensitive properties of advanced permanent magnet materials. Major advances in understanding high-temperature superconductivity have resulted from the wide variety of measurements made by the combined efforts of many groups at BNL.

Chemical Sciences: There are ten groups distributed between the Chemistry Department and the Department of Applied Science doing research into photochemistry and radiation chemistry, chemical physics and chemical energy. The photochemistry program explores the efficient capture and storage of light energy, including studies of transition metal complexes, electron-transfer reactions, charge transfer excited-states and the photodecomposition of H_2O and CO_2. A new pulse radiolysis facility enables synchronized laser- and electron-pulses to be applied to ultrafast radiation and photoinduced reactions in research on supercritical fluids and radiation chemistry in waste remediation. In chemical physics, high-resolution spectroscopy is applied to the fundamental studies of molecular processes in combustion of carbon-containing fuels. There is research into the optical control of molecular fragmentation using intense laser fields in the non-perturbative limit and is a new initiative on radical-radical reactions. The program in chemical energy centers around the study of homogeneous catalysis with

metal hydrides and heterogeneous catalysis/surface science. The latter is a major component in the work on catalysis and interfacial chemistry probing chemical catalysis from a multi-faceted perspective by combining in-situ studies of the surface and bulk using x-ray and neutron diffraction and x-ray absorption spectroscopy and UV photoemission with studies of the dynamics of photo-induced fragmentation processes in the gas-phase and on surfaces using state- and energy-resolved laser spectroscopies.

Programs aimed at technologies for carbon sequestration include the role of porphyrins in bioenergetic reactions, such as photosynthesis and electrochemistry studies of the fundamental aspects of electron transfer. The Chemical and Engineering Sciences Program supports research in fundamentals of batteries. The Separation and Analysis Program supports research on the atomic structure of liquid-solid interfaces. There is also an expanding program on the nucleation dynamics in microparticles and the chemical characterization of ultrafine particles, which explore the aerosols generated by energy production and industrial processes.

Geosciences: In collaboration with the NSLS, an active program in x-ray microtomography probes the interior of geological samples to determine both fluid flow and mechanical properties in porous media, and studies the distribution of trace elements in plants and insects. Another program studies the chemistry of polysulfides in rich marine sediments, the incorporation of sulfur into organic matter, and the effect of such incorporation in preserving sedimentary organic matter.

Energy Biosciences: Fundamental and applied research is directed toward a fuller understanding of the genetic, physiological, and biochemical mechanisms of higher plants. Recombinant DNA technology is used to develop genetic and physical maps of economically important plants, such as maize.

Biological and Environmental Research (OBER)

Programs sponsored by the DOE OBER are carried out in several departments: Applied Science, Biology, Chemistry, and Medical. The focus ranges from medical applications of nuclear technology, basic and applied molecular, structural, cell and radiation biology, to epidemiology and environmental research.

Basic research programs include understanding genetic and biochemical processes and structure-function relationships. We study genome organization, DNA damage, and repair, replication, genetic recombination, mutagenesis and carcinogenesis, control of gene expression, mechanisms of enzyme action, and structures and functions of proteins and complexes, such as chromatin, ribosomes, viruses and membranes. This strong core of basic research gives us the capability and flexibility to respond to DOE initiatives, such as those in structural biology, genome research, biotechnology and molecular medicine.

BNL has a unique set of user facilities for structural biology, including stations at the NSLS for x-ray diffraction and data analysis, and vacuum ultraviolet spectroscopy, stations for neutron diffraction and scattering at the HFBR, and the scanning transmission electron microscope (STEM) for high-resolution measurement of molecular shapes and masses. These facilities represent a powerful combination of tools for examining structures of macromolecules. The types of information obtainable include 3D location of atoms in individual molecules or structures, the arrangements of molecules in higher-

order structures, and the overall shapes and interactions of complexes of molecules. Such information is basic for understanding how biological molecules and structures function, which, in turn, provides critical insights and support for molecular genetics, biotechnology, genome research, and medicine.

The ***Protein Data Bank (PDB***) which is supported by DOE OBER, NSF, NIH, and NLM is the world-wide depository for three-dimensional structural information for all types of biological macromolecules. In recent years, an explosion of activity in structure determination rapidly increased the size of the PDB and made it an increasingly important resource for structural biology, molecular genetics, and genome studies. Researchers are placing demands on the PDB for new kinds of information and new ways of dealing with it. Interactions between the PDB and the researchers who rely on it are critical for maintaining a resource that supplies the needs of the biotechnology revolution.

Genome Research is focused on the rapid development, testing, and export of capillary technology for high-throughput sequencing, and on the nested-deletion strategy for targeted sequencing of difficult-to-sequence regions. A pilot project in functional genomics is being developed to clone, express, purify, and crystallize proteins to test the likelihood of obtaining and analyzing crystals from different protein families.

Researchers also take advantage of the unique facilities and expertise at Brookhaven National Laboratory for their potential application in medical research. Nuclear technology and radiopharmaceuticals are used to develop new treatments, new diagnostic tools, and to study human physiology and the mechanisms of disease. There are four focus areas:

Boron Neutron Capture Therapy. The epithermal neutron beam at the Brookhaven Medical Reactor is used in conjunction with boronphenylalanine, a compound that specifically accumulates in brain tumors, to irradiate malignant cells while sparing normal surrounding brain tissue.

Imaging**.** In efforts sponsored both by DOE and NIH, researchers take advantage of the imaging capabilities at BNL (two PET scanners, one 4 Tesla MRI, and one SPECT scanner) to a) characterize the effects of drugs in the human brain and to investigate the molecular changes underlying addiction and their relationship to function and treatment; b) investigate molecular changes underlying normal aging and their relationship to vulnerability to neurodegenerative disease and to treatment; c) investigate the actions of therapeutic drugs in the human body to optimize their beneficial effects, minimize toxicity, and expedite their introduction into the practice of health care.

Radioisotopes**.** In a program supported by both DOE-NE and DOE-OBER, BNL supplies isotopes for medical diagnosis in the United States, and develops and evaluates radiopharmaceuticals for cancer diagnosis and treatment.

Instrumentation**.** Research is ongoing at the NSLS to develop new radiation treatments based on the delivery of very narrow beams of high doses of irradiation to treat malignant brain tumors. These narrow beams allow a significantly higher dose of radiation be delivered to the brain without the problems of irradiation necrosis encountered with conventional treatments. The NSLS also is being used for CT scanning, mammography and bronchography. The high flux can generate a

monochromatic ray that has a considerably improved contrast gradient for structures with different densities than those obtained with conventional x-ray machines. At the Whole Body Counting Facility, researchers are investigating changes in the body's elemental composition associated with aging, obesity, and disease.

Environmental Processes: The goal of this program is to provide basic information and models of the transport and fate of fossil-fuel derived atmospheric pollutants. The *Free-Air Carbon Dioxide Enrichment (FACE)* program involves the development and use of facilities that expose ecosystems to elevated levels of CO_2 in a controlled fashion. The goal of the *Chemistry and Microphysics of the Troposphere* is to establish an understanding of the chemical and physical processes that determine the fate of energy-related pollutants emitted into the atmosphere.

The *Atmospheric Radiation Measurement (ARM) Infrastructure* program is a decade-long project to measure atmospheric radiation, and the factors that control it. Work includes fuel experiments, campaign planning, and the development and maintenance of databases. In particular, the ARM External Data Center is located at BNL.

Two important programs in marine science are complete and are coming to a close. *Inorganic Carbon Measurements for the World Ocean Circulation Experiment (WOCE) World Hydrographic Program* provides a detailed map of distribution of CO_2 within the world's oceans. *The Ocean Margins Program* focused on the continental shelf to understand the transport and mixing of water masses, the effect of these processes on primary and secondary production, and the transport of carbon through the system.

Environmental Remediation: The focus of this program is to understand the role of microbes in reducing the concentration of environmental radionuclides and heavy metals. Brookhaven has a long history in bioremediation and holds a patented process. We intend to expand this area in response to DOE's new program emphasis, with upgraded laboratory facilities and new scientists.

In the *NABIR - Natural and Accelerated Bioremediation Research* program, work has begun on our first new program, the *Transformation of Heavy Metal Contaminants in Sulfate-Reducing Sub-surface Environments: The Role of Thiolated Compounds and Hydrogen Sulfide*. Remediating soils and marine sediments contaminated by radionuclides and toxic metals is challenging because these cannot be degraded, unlike most organic pollutants.

Energy Efficiency and Renewable Energy (EE)

Geothermal Energy: Brookhaven's expertise in developing natural microbes for bioremediation extends to biocatalysts for geothermal brines. Research and development has resulted in *Advanced Biochemical Processes for Geothermal Brines* whose chemical content without processing often causes them to be classified as toxic or regulated wastes. Here, biocatalysts have been identified which can convert insoluble species of toxic metals, including radionuclides, into soluble forms.

Geothermal Materials Development addresses the other significant technical issue facing the development of geothermal power, namely, the need for high temperature,

corrosion resistant, chemically inert coatings, cements and grouts. This program is closely coordinated with private sector investments in geothermal development.

Buildings: *Thermal Distribution Systems in Small Buildings* addresses the issue of heat loss in residences. The *Combustion Equipment Space Conditioning Technology* program deals with improving residential heating systems. To date, these activities have resulted in over 0.83 quads of cumulative distillate oil savings. The *Krakow Clean Fossil Fuels* program assisted the City of Krakow, Poland, to reduce emissions and improve air quality. Current research, which we expect to continue, addresses the degradation in efficiency associated with fuel composition and combustion characteristics, the lack of control options for monitoring system performance, mechanisms for safely venting combustion products from very high efficiency systems, and the lack of a mechanism for technology transfer within the industry.

Natural Gas: The *Natural Gas Storage Systems* program is addressing the production of LNG from landfills, remote well sites, pipeline gas, and coal mines. Other issues involve developing state-of-the-art storage tanks and refueling facilities, the design of novel cryogenic fuel delivery systems, and market end-use strategies. LNG fuel handling on the vehicle includes such topics as fuel-tank design, vaporizer development, high pressure fuel delivery, and engine specifications.

***Photovoltaics*:** In support of the DOE Photovoltaic Program, BNL programmatic activities focussed on minimizing the potential adverse environmental, health and safety impacts associated with the production, delivery, and use of photovoltaic energy. In the upcoming year, special emphasis will be placed on DOE's Million Roof Program.

Fossil Energy (FE)

Work in *Biochemical Upgrading of Petroleum* continues our core capability in microbial science. Here, we use microbes to reduce the sulfur, nitrogen, and trace-metal content of crude oils. Work thus far has focused on demonstrating technical feasibility with different types of biocatalysts under a variety of processing conditions and with different heavy crudes. The economics of the process are also considered. The development of this technology has strong ties to the biochemical research in the geothermal program. We are working closely with the Economic Development and Technology Transfer office to build a pilot plant and transfer the technology to the oil producers; a joint DOE-industry program is under development with a start-up company, BioCat, formed to commercialize the process.

BNL is supporting the DOE's Office of Fossil Energy (FE) to analyze environmental, health, and safety issues associated with the release of hazardous pollutants from coal-fired power plants, and air-quality standards for particulate matter. In addition, we are investigating a process involving methanol synthesis through methane decomposition as a viable alternative for methanol production, with reduced emissions of carbon dioxide and toxic gases.

National and Global Security (NN)

This is a growth area for BNL emphasizing the safeguarding of Russian special nuclear materials, providing technologies to the United States to support treaty

verification, and preventing, detecting and responding to events associated with weapons of mass destruction (international and domestic situations).

Currently work for the DOE Office of Nonproliferation and National Security (NN) supports the development of advanced technologies to aid in detecting and countering emerging proliferation threats. BNL's staff provide technical assistance in several focus areas to secure nuclear material in the former Soviet Union, establish transparent and irreversible nuclear reduction, strengthen the nuclear nonproliferation regime, assure safe storage/disposition of surplus fissile material, and help develop non-military applications for defense technologies/personnel. Currently, there are over 40 lab-wide projects, each designed to help stabilize Russian scientific and technical personnel/resources that represent a proliferation risk. BNL staff are also engaged in developing hardware and systems for treaty verification and nuclear, chemical, and biological nonproliferation through efforts in Raman LIDAR, Radiation Detection, and the Satellite Data Review Panel.

BNL scientists, along with scientists from other national laboratories, are providing technical assistance in designing and installing upgraded nuclear material protection, control, and accounting (MPC&A) systems at sites where nuclear material is inadequately protected from insider and outsider threats, such as in Russia, the NIS and the Baltic States. Technical support in other international safeguards programs involves activities and initiatives, such as participation in the fissile material production cutoff talks, US/IAEA agreements, the U.S. excess nuclear materials offer, and the IAEA Strengthened Safeguards System. Technical support is provided in areas related to HEU purchase transparency, START-III, transparency, dismantlement verification systems (CIVET) for START-III and the Mayak Storage facility, and the US/Russia Plutonium Production Reactor Agreement. BNL is developing radiation-measurement systems for assaying nuclear materials for domestic safeguards and for verifying the presence of nuclear components in weapons returned to the DOE complex.

Nuclear Energy, Science and Technology (NE)

The DOE Office of Nuclear Energy (NE) has been conducting a comprehensive, cooperative effort to reduce the risks at Soviet-designed nuclear power plants. With various host countries, joint U.S. projects that are managed through the International Nuclear Safety Program Office are correcting major safety deficiencies and establishing nuclear safety infrastructures that will be self-sustaining. U.S. specialists, including BNL staff, under the programmatic leadership of PNNL, have initiated more than 150 joint projects at RMBK and VVER nuclear installations, many of which have had an immediate impact in reducing risk. BNL's focus has primarily been in areas of training, simulator development, safety-system upgrades, fire-hazard analysis, and technology transfer.

Defense Programs (DP)

The DOE Office of Defense Programs (DP) provides an infrastructure and intellectual capability to maintain the nuclear weapons stockpile, including replacing limited life components and assuring an adequate supply of tritium for nuclear weapons. The Accelerator Production of Tritium (APT) system could easily, safely, and adequately meet the nation's tritium needs, a conclusion is based on system-designed reviews involving BNL scientists. We provide technical support to the APT Program Office,

based at LANL, in several areas including APT systems engineering, safety, materials characterization/evaluation, and target/ blanket design and engineering. There will be a selection later this year of either the accelerator approach or a light water reactor approach that may affect our future involvement

BNL also supports work related to safety functions and responsibilities at Defense Program facilities and verification of integrated management systems, and assists the Russians in decommissioning their nuclear submarine fleet, scheduled for completion late in FY98.

Environment, Safety, and Health (EH)

The DOE Office of Environment, Safety and Health (EH) develops and implements a comprehensive management, organization, and personnel program to improve the safety performance of individuals and human systems and their interactions with technical systems. BNL also supports several areas including reviewing site-wide and programmatic Environmental Impact Statements, analyzing operating experience at DOE facilities, Secretarial EH Initiatives such as the Interagency Nuclear Safety Review Panel, and complex-wide vulnerability assessments. BNL has provided support in developing and applying a worker safety assessment methodology for DOE facilities, in helping to develop nuclear facility safety rules/guides, and in addressing specific safety issues involving backfits, seismic vulnerability, and accelerator-driven systems.

BNL continues the radiological safety program for the inhabitants in the Northern Marshall Islands. Ultra-sensitive plutonium screening and sampling protocols, developed by BNL scientists, were implemented that are based on fission track analysis using high performance liquid chromatography and inductively-coupled plasma mass spectrometry. This program is evolving towards alternative technologies to support the analysis. Methodologies for maintaining quality data, cost-effectively will continue to be key drivers for this program.

Environmental Management (EM)

Programs are in place from the Mixed Waste Focus Area and Subsurface Contaminants Focus Area and from Decontamination and Decommissioning. This work involves designing, testing, and demonstrating innovative technologies to treat DOE wastes and cleanup contaminated sites throughout the DOE complex.

Policy Office

We will continue to support the DoD/DOE/EPA program on Arctic Military Environmental Cooperation, an activity coordinated through the DOE Policy Office; BNL will continue to work on the emerging program on environmental security. We will provide assistance, through systems modeling assessments of global climate change and integration with the MARKAL-MACRO energy system model tool, which was developed at BNL. Currently, BNL chairs the Laboratory group assembled to document all available analytical tools for modeling global change.

A2 Work for Others

National Aeronautics and Space Administration (NASA)

The AGS is currently accelerating Fe ions to energies up to 1.0 GeV per nucleon in a radiobiology program for NASA's Space Radiation Health and Radiation Biology Division to expand a very limited experimental data base relevant to long missions into interplanetary space by humans. This program runs for two weeks of beam per year, with heavy ion irradiation's for 20-30 experiments annually. The users are approved and funded by NASA, and the AGS time is purchased by NASA.

National Institute of Health (Department of Health and Human Services)

Several of BNL's centers and facilities are developed and operated through partnerships with and funding from the National Institute of Health. Such partnerships include the development of facilities for synchrotron crystallography at the NSLS as well as support to our Center for Imaging and Neuroscience and the Scanning Transmission Electron Microscope. NIH also provides substantial support through research grants to individual investigators. Currently, researchers are working on DNA damage and repair, protein structure and folding, a viral protease and receptor and Lyme disease bacterium.

Environmental Protection Agency (EPA)

New York Harbor is now faced with an operational crisis on the removal of sediments and soils contaminated with a variety of toxic materials produced by humans. The crisis was brought about by stricter regulations that reduce the amount of dredged material considered suitable for ocean disposal in the coastal Atlantic. Supported by EPA Region 2, this project investigates commercial technologies for sediment decontamination.

International cooperation is critical to achieving EPA's mission. The EPA Office of International Activities (OIA) enlists the cooperation of other nations in solving environmental problems of concern to the United States. BNL staff are assisting this office in the design of, and providing oversight in, the construction of a waste processing facility in Murmansk, Russia. We are providing technical support in evaluating Russian waste treatment technologies, and, through OIA, are fostering environmentally sound, sustainable development initiatives in Kazakstan.

Department of Defense (DOD)

Portable Power Generator - With DARPA funding, we developed a novel high performance oil-fired thermophotovoltaic system for generating electric power under field conditions. Currently we are scaling up and refining the design.

Polyplanar Optic Display (POD) is an advanced, state-of-the-art, projection display screen developed and patented by BNL scientists that can produce large images with high contrast and resolution using any projection source. BNL recently produced a new, laser-driven display providing high resolution imagery in a small package for use in aircraft cockpits. The U.S. Air Force PRAM Office is funding the development of this

technology; DARPA has provided funds for large-screen development. We expect this program to expand due to the support it is receiving from upper management.

Ultra-sensitive Plutonium Screening and Sampling Protocols used in the DOE-funded Marshallese dose-assessment project are being applied, under sponsorship from the Defense Special Weapons Agency, to assay Pu-238 uptake in veterans who participated in above-ground nuclear testing or in the occupation of Hiroshima and Nagasaki.

Biological Particles - We support the U.S. Army in the Chemical and Biological Defense Command (CBDCOM) in assessing the fluorescence properties of humidified- and coated-biological particles.

U.S. Nuclear Regulatory Commission (NRC)

BNL staff perform a range of technical assistance and experimental and theoretical regulatory research for the NRC. This work includes integrated risk assessment and reliability analysis, thermal-hydraulic and neutronic analyses, evaluations of degraded core- and fission-product release, determination of containment response, offsite-consequence modeling, human-factors analysis, structural-, mechanical- and earthquake-engineering analysis, operational safety assessments, acceptability reviews of plant-specific safety issues, and appraisals on fire-protection features in nuclear power plants.

BNL constructed and operates for the NRC the High-Temperature Combustion Facility (HTCF), a unique facility for investigating high-temperature, high-speed combustion phenomena (including detonations). The Laboratory provides valuable information on the environmental qualification of aged electrical cables using experimental condition-monitoring resources housed in our Electric Cable Test Facility. BNL has given training and technical support in ALARA, and is heavily involved in technology transfer and training of regulatory staff in the countries of the former Soviet Union. We also collaborate in seismic research with NUPEC of Japan.

Department of State

The Department of State funds Brookhaven's International Safeguards Project Office (ISPO) which supports the IAEA in nuclear safeguards. ISPO provides ongoing technical review and management of the U.S. Program of Technical Assistance to IAEA Standards (POTAS), as well as advice on new initiatives to enhance the effectiveness and efficiency of IAEA safeguards. Currently, ISPO tracks nearly 100 active projects. Additional funds may be secured for initiatives focussing on Russian radioactive waste management.

Federal Aviation Administration (FAA)

BNL staff have exploited their expertise in risk and reliability analysis and assessments of threats by insiders and outsiders to assist several branches of the FAA in aircraft system reliability, availability, maintainability, and in airport security. Two members of our staff were appointed by the FAA to a Blue-Ribbon Panel in response to the White House Commission on Aviation & Security. Several others are employing

probabilistic risk analysis techniques, which were honed through nuclear power plant applications, to glean risk-related insights from recent incidents and accidents of commercial aircraft and for improving the reliability of specific aircraft components.

A3 Economic Development and Technology Transfer

In the new DOE-BSA Prime Contract, the Performance Measures Plan sets forth four goals for the Science and Technology Program, the last of which is to "Add value to the U.S. Economy through the development and application of new and improved technologies". The focal point for accomplishing this goal at Brookhaven is the newly named Office of Economic Development and Technology Transfer (OTT). The OTT manages an active technology transfer program which 1) permits the early identification of emerging products or processes developed at BNL that may be of commercial interest; 2) identifies unique technical capabilities and facilities that may be of interest to industry, universities, and state and local governments; 3) provides an outreach function to bring these new technologies and unique capabilities and facilities to the attention of private industry, universities, and state and local government; and 4) establishes research collaborations that allow Brookhaven to be a resource to the university community and industry.

With the support of the Economical Development and Technology Transfer Office, staff develop cooperative programs with the private sector to both commercialize technologies, and support the technology needs by outside partners. We are aggressively pursuing funding sources from the private sector to sustain and enhance our core competencies for DOE missions. The following are some of the more productive initiatives we have undertaken:

- Completed Phase 1 of the design of the RAPTOR, a device for breaking concrete with a two-stage, light-gas gun for accelerating projectiles at hypersonic speeds. This included research in the characteristics of concrete, velocity effects, and projectile design. (*Sponsor: Gas Research Institute)*
- Completed calculations using terrestrial magnetic fields to image underground utilities. An early design of the MAGPIPE device based on these calculations was completed and the components ordered. *(Sponsor: Consolidated Edison Co. of NY)*
- Submitted the final report on "New Infrastructure Technologies, Potential Needs and Applications." *(Sponsor: NYS Research Foundation)*
- Completed a technology transfer and maturation CRADA with MetaRisk. Based on BNL models, a computer-based audit process was designed and tested for use in evaluating corporate liability risk through their substance abuse policies and practices. This work resulted in a successful start-up company. (*Sponsor: MetaRisk and DOE)*
- Developed Performance Indicators for aircraft repair stations and training of air personnel training based on the SPAS data base. *(Sponsor: Crown Communications)*
- Supported the air-crash investigation of TWA's Flight 800. *(Sponsor: FBI/NTSB)*
- Provided technology transfer for commercializing BNL-developed polyethylene microencapsulation process for packaging mixed, hazardous waste. *(Sponsor: Envirocare of Utah)*
- Performed studies of high-current electron accelerator stability studies. *(Sponsor: PNC of Japan).*

- Carried out design calculations on accelerator-based transmutation systems. *(Sponsor: JAERI)*

Appendix B User Facility Tables

Table 14 - EXPERIMENTERS AT USER FACILITIES
FY 1998

	Number of Experimenters	Number of Organizations
RELATIVISTIC HEAVY ION COLLIDER		
BNL	108	1
Other Federal Labs	128	6
University	273	36
Industry	0	0
International	434	47
	943	90
ALTERNATIVE GRADIENT SYNCHROTRON		
BNL	92	1
Other Federal Labs	67	14
University	399	61
Industry	2	1
International	279	52
	839	129
NATIONAL SYNCHROTRON LIGHT SOURCE		
BNL	220	1
Other Federal Labs	279	25
University	1213	141
Industry	264	61
International	354	132
Other	50	10
	2380	370
SCANNING TRANSMISSION ELECTRON MICROSCOPE		
BNL	8	1
University	53	28
Other Federal Labs	5	2
Other	5	2
	71	33
ACCELERATOR TEST FACILITY		
BNL	19	1
Other Federal Labs	23	5
University	16	11
Industry	4	14
International	4	1
	66	32

Table 15 - INDUSTRIAL AND TECHNOLOGICAL USERS OF THE NSLS

3-Dimensional Pharmaceuticals, Inc.
Abbott Laboratories
Advanced Fuel Research
Air Products & Chemicals Inc.
AlliedSignal, Inc.
Amoco Corporation
Applied Physics Technologies Corp.
Area Detector Systems Corporation
Bayer Corporation
Bechtel Nevada
BioSpace International Inc.
Biological Research Center
Boehringer Ingelheim Pharmaceuticals, Inc.
Bristol-Myers Squibb
Bruker AXS, Inc.
Chevron Research & Technology Company
Containerless Research. Inc.
Corning, Inc.
Crystal Technology, Inc.
David Sarnoff Research Center
Digital Equipment Corporation
Dow Chemical Company
Eastman Chemical Company
Eastman Kodak Co.
Edge Analytical, Inc.
Emerald BioStructures, Inc.
Enraf-Nonius, Inc.
Ethicon, A Johnson & Johnson Company
Exxon Research and Engineering Co.
General Electric
GlaxoWelcome, Inc.
Hoechst Celanese
Hoffmann-La Roche
IBM Research Division
IKV Petroleum Research
Instituto Tecnologico de Aeronautica (ITA)
KLA Instruments
Kawasaki Heavy Industries, Ltd.
Kinetix Pharmaceuticals, Inc.
Lockheed Engineering
Lucent Technologies, Inc.
MVA, Inc.
Matsushita Electric Industrial Co., LTD
Memstek Products, LLC
Merck & Co.
Mobil R&D Corp.
Molecular Structure Corporation
Montell Polyolefins USA
NEC Corporation
NHK Enterprises American, Inc.
Northrop Grumman ATDC
On-Line Technologies Inc.
Oxford Instruments
PPG Industries, Inc.
Pall Corporation
Panametrics, Inc.
Pfizer, Inc.
Procter & Gamble Co.
Quantum Devices, Inc.
R&D Services, Prop.
Rohm & Haas Co.
SFA, Inc.
Sarnoff Corporation
Sci-Med
Science Applications International Corp.
SmithKline Beecham Pharmaceuticals
Southern Research Institute
Spectra-Tech Inc.
St. Gobain Industrial Ceramics
TYCOM
Texaco Research Center
The DuPont Company
The EXAFS Company
UOP
Vertex Pharmaceuticals, Inc.
Wyeth-Ayerst Research

Table 16 - INDUSTRIAL AND TECHNOLOGICALUSERS OF THE BROOKHAVEN TANDEM FACILITY

Airborne Instruments Laboratory
ALCATEL Espace (France)
Alliance Technologies, Inc.
AT&T
APTEK, Inc.
Ball Aerospace Corporation
Booz, Allen and Hamilton
Centre Spatial de Toulouse (France)
CertOnera (France)
Clemson University
Computing Devices, International
Control Data Corporation
Corning Costar Corporation
Defense Nuclear Agency (DNA)
Diamond Materials, Inc.
Electromagnetic Sciences, Inc.
Epitaxx
European Space Agency (ESA)
Fairchild Space Co.
Grumman Aerospace Corporation
Hampton University
Harris Corporation
HIREX (France)
HIREC Corp. (Japan)
Honeywell (SASSO)
Honeywell (SSEC)
Hughes Aircraft Corporation
Hughes/Danbury Optical Corp.
Idaho National Engineering Lab
IBM
International Rectifier Corp.
Jet Propulsion Laboratory (JPL)
Johns Hopkins University (APL)
Lehigh University
Lockheed Martin Aerospace Corp.
Lockheed Martin Federal Systems
Lockheed Missiles & Space Corp.
LSI Logic, Inc.
Lockheed Martin Corporation
Matra Marconi Space (France)
Matra MHS (France)
McDonnell-Douglas Corporation
Mitsubishi Electric
Motorola, Inc.
Myers & Associates
NASA/Goddard Space Flight Ctr
NASA/Johnson Space Center
NASDA (Japan)
Nat'l Security Agency (NSA)
Naval Surface Warfare Center
Naval Research Lab (NRL)
NEC Corp. (Japan)
Novus Technologies
Physitron Corporation
Polytechnic University
Raymond Engineering
Raytheon
Rocketdyne Corporation
Rockwell International
S-Cubed
SAAB Space Components Lab
Sandia National Laboratories
Santa Barbara Research Center
Space Electronics
Spectrum Sciences
Toshiba Corp.
TRW
University of Idaho
University of New Hampshire
University of NM (NASA/MERC)
University of Maryland
Utd Tech Microelectronics Ctr

Appendix C MEL/FS Projects

Multi-program Energy Laboratories and Facilities Project Description

The following proposed projects are based on BNL's anticipated / expected requirements which were developed to allow the Laboratory to meet its mission and critical outcomes.

Proposed Projects - GPF (KG-01)

Electrical System Modifications - Ph I (FY 99)

DOE and BNL's consulting engineers have emphasized the vulnerability of the electrical distribution systems and have recommended replacing deteriorating cables and ductbanks. This project covers the first phase of replacing existing old and deteriorating underground electric 13.8 kV cables and adding underground duct banks to support the cable systems. The existing cables, installed in the late 1940s, have outlived their useful life and will be replaced with new, solid dielectric shielded cables. New electric ductbanks and manholes for power and communication will support the new cable installations. Tin addition, approximately 100 fifty year old power circuit breakers will be reconditioned and updated with modern solid-state trips devices. This project will increase system reliability by reducing the number of unplanned outages to the Laboratory's research facilities and their duration. Direct repair costs associated with a typical 13.8 kV feeder failure are approx. $60 - $100 k and can cause program downtime of 16 to 48 hours.

Central Steam System Rehab (FY 00)

The Central Steam System Rehabilitation project will replace deteriorated portions of BNL's underground steam distribution system and extend the service life of the Central Steam Facility's (CSF) largest boiler. This project is required to ensure a reliable and safe steam supply to the majority of programmatic facilities in the core area of the BNL site.

The BNL Central Steam System provides steam for heating, humidification and process cooling to the majority of BNL's programmatic facilities. Major sections of the BNL steam distribution system were constructed in the late 1940's and early 1950's and are nearing the end of their useful life. This project continues BNL's program to correct code and operational safety deficiencies in its steam system.

Roofing Replacement Phase II (FY01)

A 1989 roofing study report concluded that over half of the roof area studied was in poor to failed condition, and needs replacing. Roof replacements compete with other needs and the backlog of these projects continues to grow. This project would provide funds to replace roofing systems. There is a current backlog of over $7,000,000 for built-up roofs that are beyond there useful life and have failures in various components. The BNL site has 2,980,000 sq.ft. of built-up roofing.

Maintenance cannot be expected to further prolong the life-cycle of these roofs as deterioration from normal aging, and deterioration from referred maintenance has resulted in increasing failures.

Dept. of Advanced Tech. Bldg. - Phase I (FY02)

The Department currently occupies all or part of 10 buildings, most of which are either World War II era barracks, wooden modular buildings, or old permanent-type construction. This decentralized distribution of staff in old, ineffective buildings is demoralizing and decreases effective interchanges between staff members. Distances between buildings also make it inefficient for administration and management of the Department. Centralization of the staff would improve the working relationships, efficiency, and productivity of DAT staff.

The proposed Phase I building would be located near existing permanent structures which house the major portion of experimental equipment/facilities used by the department. This phase would consolidate a significant part of the Department's administration, management, scientific, engineering and experimental staff, and result in reduced maintenance costs for the associated space.

Electrical System Modifications - Phase II (FY02)

This project continues the progress made in Phase I by replacing old deteriorating underground electric 13.8 kV cables and adding supporting underground ductbank. The existing cables have outlived their useful life and will be replaced with new solid dielectric shielded cables. Based on condition assessment, other electrical equipment including transformers and switchgear will be replaced and/or retrofitted to extend their useful life.

High Speed Fiber-Optic Infr. - Ph. I (FY03)

The National Information Infrastructure is now a reality, The late 1990's saw millions of commercial entities embrace the Internet as a medium for conducting business. The World Wide Web browser sparked a revolution that has brought with it a radical increase in demand for network bandwidth. Network providers are scrambling to increase their throughput and remove bottlenecks. The traffic on the Internet is increasing so rapidly that it cannot be predicted confidently from year to year and video tele-conferencing over the Internet still is not widely used.

The Laboratory's infrastructure is, and has historically been, driven by near-term departmental centric projects that prioritized initial cost above all else. The resulting network that is very manpower-intensive and lacks an upgrade path to higher band-widths. The only way to properly anticipate future requirements on the BNL network is through a consistent, long-term plan that does not require each department or division to allocate funds separately. This project will be a major step toward meeting the Laboratory's communications needs well into the future.

Central Steam System Rehab - Ph. II (FY03)

This continuation of the Central Steam System Rehabilitation project will replace deteriorated portions of BNL's underground steam distribution system and extend the

system to buildings currently serviced by old local boilers which will be in need of replacement. This project is required to ensure a reliable and safe steam supply to programmatic facilities.

The BNL Central Steam System provides steam for heating, humidification and cooling to the majority of BNL's programmatic facilities. Major section of the BNL steam distribution system were constructed in the late 1940's and early 1950's and are nearing the end of their useful life. This project continues BNL's program to correct code and operational safety deficiencies in its steam system.

Roofing Replacement Phase III (FY03)

A 1989 roofing study report concluded that over half of the roof area studied was in poor to failed condition, and needs replacing. Roof replacements complete with other needs and the backlog of these projects continues to grow. This project will continue to provide funds to replace roofing systems to reduce the backlog which continues to grow.

Further maintenance cannot be expected to further prolong the life-cycle of these roofs as deterioration from normal aging, failures from abuse, and deterioration from referred maintenance has resulted in increasing failures.

Applied Science Center - Phase II (FY04)

Phase II represents a continuation of efforts to consolidate the Department of Applied Science (DAS). This addition to Building 815 will accommodate the Oceanographic and Atmospheric Sciences Division now primarily housed in Buildings 318 and 194. With this addition DAS will no longer need Building 318, a high maintenance 55 year old building. Demolition of Building 318 will result in a net reduction in maintenance costs for this associated space.

Central Chilled Water - Phase II (FY04)

The refrigeration capacity of the chilled water plant will be increased by an additional 13,125 kW (3,750 tons). The chilled water piping will be extended to connect seven additional buildings to its distribution network. Compressed air piping also will be extended in parallel with the chilled water distribution system. Benefits of this project include:

- Chiller system replacement cost offsets in the $7-10 M range.
- Annual energy and operations & maintenance savings of over $1.0 million/yr.
- Frees up mechanical and other buildings space for other uses.
- Increases system reliability and process temperature stability. Decreases noise and vibration in buildings.

Proposed Projects - ES&H Support (KG-02)

Sanitary System Modifications - Phase III (FY99)

This phase of the overall project will address those deficiencies identified in the Sanitary System Master Plan, which were not scoped in previous phases. This project

will continue the Laboratory's program to replace and repair leaky sewer mains to protect Long Island's sole source aquifer. The Wastewater Treatment Facility sand filter beds and holding ponds will be fitted with liners. In addition, the sanitary system will be expanded to incorporate six building complexes at the RHIC site.

Ground & Surface Water Protection (FY00)

project will implement several upgrades to systems and facilities needed to comply with Suffolk County Sanitary Code Article 12 and protect Long Island's sole source aquifer. The upgrades will include elimination of non-compliant discharges, reduction of non-contact cooling water, elimination of radiologically contaminated cooling systems and installation of secondary containment and leak detection on several systems containing hazardous fluids.

Site Security / Visitors Center (FY01)

This project will enhance BNL's site safety and security. A Visitor Center will be constructed to welcome site visitors. Functions such as badging, contractor training, and some Human Resources functions will be relocated to this facility, thus assuring visitors are adequately trained and oriented to the site. In addition, the site will be fenced to limit access to hazardous areas, which tend to be an attraction to local youths. Fencing will reduce vandalism, damage and other potential liabilities associated with unauthorized access to radiological and hazardous facilities.

Life Safety Code Modifications - Phase I (FY02)

Sixteen buildings will be upgraded to comply with National Fire Protection "Life Safety Code" NFPA 101. This project will bring the facilities into compliance and make them safer for their occupants. Upgrades include modifications to building egress, stairwells, firewalls, sprinkler systems, emergency lighting, smoke detector systems, and other related requirements.

Asbestos Abatement - Phase I (FY02)

The project continues current Laboratory programs to correct potential environmental safety and health problems. Up to eight selected buildings will have asbestos insulation and asbestos-containing material removed from ducts, piping, equipment, structural components, and surfaces.

Halon System Replacement (FY02)

This project encompasses the replacement of Halon Systems due to environmental mandates (ozone depletion) - the Clean Air Act 1990. The Montreal Protocol and its amendments in 1993 demonstrate the need to phase-out halon systems. A project is needed to decommission and replace these systems with acceptable alternatives to maintain compliance with DOE's Fire Protection Standards. BNL has less than 100 halon systems. The replacement systems will include sprinkler systems, and

very-early-warning detection (VESDA) or carbon dioxide systems (only for unoccupied areas). Halon fire extinguishers also will be replaced with suitable alternatives.

Life Safety Code Mods.- Ph. II (FY03)

Additional buildings will be upgraded to comply with National Fire Protection "Life Safety Code" NFPA 101. This project will continue to bring the facilities into compliance and make them safer for their occupants. Upgrades include modifications to building egress, stairwells, firewalls, sprinkler systems, emergency lighting, smoke detector systems, and other related requirements.

Hot Lab Renovation Building 801 – Ph. II (FY04)

This project will renovate the eastside of Building 801 (the Hot Lab "Cold Side"). Line Item remedial and renovation actions will include the abatement of asbestos and lead, adding office space, upgrading laboratories, and replacing the inadequate, deteriorated HVAC systems. The costs for a new building to replace the required space in Building 801 and demolition of Building 801 would be significantly higher than the proposed remediation and renovation work.

Replace Site Fire Alarm System (FY04)

This project will replace BNL's Site Fire Alarm System (SFAS) and includes all building panels, primary, backup, developmental and three remote computer stations (remote alarm stations). Replacing these 40-year old building panels will improve compliance and reliability. The present site system was installed in 1988, but its technology will be obsolete by the year 2000.

Appendix D
TABLE 17 - Annual Participation in Science Education Center Programs

Postsecondary Programs	FY1996 Total	FY1996 Minority	FY1996 Female	FY1997 Total	FY1997 Minority	FY1997 Female	FY 1998 Total	FY 1998 Minority	FY 1998 Female
UNIVERSITY PROGRAMS									
Nuclear Chemistry Summer School	12	1	5	13	1	10	12	0	5
Summer Students/ERULF	35	4	13	36	17	5	45	7	22
SERS	40	1	20	17	1	9	14	3	10
Special Groups: BSP									
Student	3	3	1	0	0	0	2	2	1
Faculty	0	0	0	1	0	1	0	0	0
Special Groups Gallaudet									
Student	2	0	2	4	1	1	1	0	0
Faculty	0	0	0	0	0	0	0	0	0
NSLS/HFBR Faculty-Student Teams	25	0	6		Not Offered			Not Offered	
Graduate School Fair (est.)		Not Offered			Not Offered			Not Offered	
COMMUNITY COLLEGE TA									
CCHP Summer Students	10	8	2	11	11	4	10	10	2
Faculty/Student Teams	7	2	1	0	0	0	0	0	0
Semester Co-Op	6	2	2	5	5	5	8	3	1
Northeast Consortium (SUMS) and CC Minisemesters	17	17	6	12	3	12	17	17	6
TOTAL	**145**	**37**	**53**	**99**	**39**	**47**	**109**	**42**	**47**

Table 17 (cont'd): Annual Particpation in Sci Ed Center Programs

Precollege Programs	FY1996 Total	FY1996 Minority	FY1996 Female	FY1997 Total	FY1997 Minority	FY1997 Female	FY 1995 Total	FY 1995 Minority	FY 1995 Female
SCHOOL DISTRICT TA (SDTA)									
Community Summer Science (HS)	26	4	11	40	6	16	40		
NYS Summer Environ Inst (HS)	6	0	3		Combined with CSSP			Combined with CSSP	
Semester Research Interns	2	0	1	3	0	3	7	0	5
Women in Science (HS)	30	1	30	30	1	30	29	0	29
DOE Science Bowl (HS)	150				Not Offered			Not Offered	
Saturday Science (JHS)	153			0			0		
Magnets-to-Go (5-6)	1939				Not Supported by OEP			Not Supported by OEP	
Science Fair (K-6)	750			760			650		
Visiting Scientist/Scientists in Residence	150			150			150		
NYS Mentoring Program				40			20		
SDTA Special Services (teacher/admin)	15						77		
SDTA Special Services (students)	155						220		
MINORITY PIPELINE (SUMS)									
Northeast Consortium		Not Supported by OEP			Not Supported by OEP			Not Supported by OEP	
Environmental Education Outreach		Not Offered			Not Offered			Not Offered	
MHSAP/NIH Summer Appenticeships	33	33	18	28	28	18	30	30	
NIH Summer Research Apprenticeship		Not Offered			Not Offered			Not Offered	
Introduction to Computers		Not Supported by OEP			Not Supported by OEP			Not Supported by OEP	
SUMS HS Minisemester		Not Offered			Not Offered			Not Offered	
SUMS Exploration Days									
TECH ED/MST INT (PAST)									
Annual BNL Systemic Conference		Not Offered			Not Offered			To be Decided	
MAGLEV Tech Ed Consortia (approx)	400			300			300		
Technology Educator's Workshops	38	1	0	30	1	0	30		
MST Conference Workshops	30			40			40		

Table 17 - (cont'd): Annual Particpation in Sci Ed Center Programs

	FY1996			FY1997			FY 1998		
	Total	**Minority**	**Female**	**Total**	**Minority**	**Female**	**Total**	**Minority**	**Female**
TEACHER ENHANCEMENT (PTEP)									
Annual BNL Systemic Conference (SITE)	96				Not Offered		15		
NYU Teacher Res. Assoc.	4	4	3	3	3	2	2	2	0
DOE Teacher Res. Assoc (TRAC)	17	2	4	1	0	0	2		
NSF/DOE Nat.Tchr. Enhancemnt (NTEP)	30	23	5	30	5	23	6	1	4
NSF Elementary MST (MSTe)				61	6	47	61	6	47
HS Teachers' In-Service Course									
SUMS MHSAP Internships		Not Offered			Not Offered			Not Offered	
DOE/NSF Co-op Appointments							6		
TOTAL	**3990**	**68**	**75**	**1473**	**39**	**139**	**1638**	**39**	**85**

Table 18 - LABORATORY STAFF COMPOSITION
Data Effective May 1, 1998

	PhD		MS/MA		BS/BA		OTHER		TOTAL	
	#	%	#	%	#	%	#	%	#	%
PROFESSIONAL STAFF										
Scientists	469	73.7%	82	12.9%	75	11.8%	10	1.6%	636	20.3%
Engineers	103	20.6%	188	37.6%	181	36.2%	28	5.6%	500	15.9%
Management & Administrative	40	10.4%	91	23.8%	111	29.0%	141	36.8%	383	12.2%
Other Professional	6	1.7%	10	2.8%	54	15.2%	286	80.3%	356	11.4%
SUPPORT STAFF										
Technicians	0	0.0%	9	2.1%	56	13.1%	364	84.8%	429	13.7%
All Other	0	0.0%	12	1.4%	54	6.5%	766	92.1%	832	26.5%
LABORATORY TOTAL STAFF	618	19.7%	392	12.5%	531	16.9%	1595	50.9%	3136	100.0%

Prepared by Human Resources: RGK: 5-1-98

Table 19 - 1998 EQUAL EMPLOYMENT OPPORTUNITY

Occupational Codes	Total		Minority Total		White		Black		Hispanic		Native American		Asian/Pac Islanders	
Gender	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Officials/ Managers	478	78	37	14	441	64	6	5	7	2	0	0	24	7
	86.0%	14.0%	6.7%	2.5%	79.3%	11.5%	1.1%	0.9%	1.3%	0.4%	0.0%	0.0%	4.3%	1.3%
Professional Staff														
Scientists & Engineers	743	131	132	39	611	92	10	3	13	3	0	0	109	33
	85.0%	15.0%	15.1%	4.5%	69.9%	10.5%	1.1%	0.3%	1.5%	0.3%	0.0%	0.0%	12.5%	3.8%
Management & Administrative	305	146	30	20	275	126	15	10	3	4	1	0	11	6
	67.6%	32.4%	6.7%	4.4%	61.0%	27.9%	3.3%	2.2%	0.7%	0.9%	0.2%	0.0%	2.4%	1.3%
Technicians	395	35	43	7	352	28	20	4	15	1	3	1	5	1
	91.9%	8.1%	10.0%	1.6%	81.9%	6.5%	4.7%	0.9%	3.5%	0.2%	0.7%	0.2%	1.2%	0.2%
All Other	459	368	112	107	347	261	71	82	30	20	5	2	6	3
	55.5%	44.5%	13.5%	12.9%	42.0%	31.6%	8.6%	9.9%	3.6%	2.4%	0.6%	0.2%	0.7%	0.4%
Totals	2380	758	354	187	2026	571	122	104	68	30	9	3	155	50
	75.8%	24.2%	11.3%	6.0%	64.6%	18.2%	3.9%	3.3%	2.2%	1.0%	0.3%	0.1%	4.9%	1.6%

Table 20 - 1993 EQUAL EMPLOYMENT OPPORTUNITY

Occupational Codes	Total		Minority Total		White		Black		Hispanic		Native American		Asian/Pac Islanders	
Gender	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Officials/ Managers	536	70	45	11	491	59	13	4	5	1	0	0	27	6
	88.4%	11.6%	7.4%	1.8%	81.0%	9.7%	2.1%	0.7%	0.8%	0.2%	0.0%	0.0%	4.5%	1.0%
Professional Staff														
Scientists & Engineers	787	150	161	18	626	102	10	1	14	3	0	0	137	14
	84.0%	16.0%	17.2%	1.9%	66.8%	10.9%	1.1%	0.1%	1.5%	0.3%	0.0%	0.0%	14.6%	1.5%
Management & Administrative	369	143	28	16	341	127	15	8	5	4	0	0	8	4
	72.1%	27.9%	5.5%	3.1%	66.6%	24.8%	2.9%	1.6%	1.0%	0.8%	0.0%	0.0%	1.6%	0.8%
Technicians	447	37	47	8	400	29	24	7	14	0	2	0	7	1
	92.4%	7.6%	9.7%	1.7%	82.6%	6.0%	5.0%	1.4%	2.9%	0.0%	0.4%	0.0%	1.4%	0.2%
All Other	525	391	125	99	394	292	83	73	37	21	0	2	5	3
	57.3%	42.7%	13.6%	10.8%	43.0%	31.9%	9.1%	8.0%	4.0%	2.3%	0.0%	0.2%	0.5%	0.3%
Totals	2664	791	406	152	2252	609	145	93	75	29	2	2	184	28
	77.1%	22.9%	11.8%	4.4%	65.2%	17.6%	4.2%	2.7%	2.2%	0.8%	0.1%	0.1%	5.3%	0.8%

Table 21 - Subcontracting and Procurement

($ in Millions-Obligated) 1/	Actual FY 1998	Estimated FY 1999	Estimated FY 2000	Estimated FY2001
Subcontracting and Procurement from:				
Universities	$5.4	$5.7	$5.8	$6.0
All Others	$115.2	$123.6	$125.3	$133.2
Transfers to other DOE Facilities	$15.5	$10.9	$11.0	$11.0
Total External Subcontracts and Procurement	$131.1	$140.2	$145.1	$150.2
1/Show total dollars obligated within each fiscal year.				

Table 22 - Small and Disadvantaged Business Procurement

($ in Millions – B/A) 1/	Actual FY 1998	Estimated FY 1999
Procurement from S&DB	$8.0	$6.5
Percent of Annual Procurement	7.8	5.0
1/ Show total dollars obligated within each fiscal year.		